DOCUMENTS

OF THE

ASSEMBLY

OF THE

STATE OF NEW YORK

ONE HUNDRED AND TWENTY-FIRST SESSION.

1898.

VOL. XXII.—NOS. 72 TO 73 INCLUSIVE.

WYNKOOP HALLENBECK CRAWFORD CO.,
STATE PRINTERS,
NEW YORK AND ALBANY.
1898.

Cornell University—Agricultural Experiment Station.

TENTH ANNUAL REPORT

OF THE

Agricultural Experiment Station.

ITHACA, N. Y.

1897.

TRANSMITTED TO THE LEGISLATURE JANUARY, 14, 1898.

WYNKOOP HALLENBECK CRAWFORD CO.,
STATE PRINTERS,
NEW YORK AND ALBANY.
1898.

STATE OF NEW YORK

No. 22.

IN ASSEMBLY,

JANUARY 14, 1898.

TENTH ANNUAL REPORT

OF THE

Agricultural Experiment Station of Cornell University.

STATE OF NEW YORK:

DEPARTMENT OF AGRICULTURE,
ALBANY, January 14, 1898.

To the Honorable the Legislature of the State of New York:

In accordance with the provisions of the statutes relating thereto, I have the honor to herewith transmit the 10th Annual Report of the Agricultural Experiment Station at Cornell University.

CHARLES A. WIETING,
Commissioner of Agriculture.

ORGANIZATION.

BOARD OF CONTROL:

THE TRUSTEES OF THE UNIVERSITY.

STATION COUNCIL.

President, JACOB GOULD SCHURMAN.

Hon. A. D. WHITE,	Trustee of the University.
Hon. B. F. TRACY,	President State Agricultural Society.
Professor I. P. ROBERTS,	Agriculture.
Professor G. C. CALDWELL,	Chemistry.
Professor JAMES LAW,	Veterinary Science.
Professor J. H. COMSTOCK,	Entomology.
Professor L. H. BAILEY,	Horticulture.
Professor H. H. WING,	Dairy Husbandry.
Professor G. F. ATKINSON,	Botany.

M. V. SLINGERLAND,	Assistant in Entomology.
G. W. CAVANAUGH,	Assistant in Chemistry.
L. A. CLINTON,	Assistant in Agriculture.
B. M. DUGGAR,	Assistant in Botany.

OFFICERS OF THE STATION.

I. P. ROBERTS,	Director.
E. L. WILLIAMS,	Treasurer.
EDWARD A. BUTLER,	Clerk.

In pursuance of the provisions of Chapter 128 of the Laws of 1897, the following persons have been appointed investigators and instructors in the College of Agriculture of Cornell University to serve throughout the State according to the needs of the several localities for a portion or all of the year.

J. W. SPENCER,	M. V. SLINGERLAND,	MISS M. F. ROGERS,
G. T. POWELL,	B. M. DUGGAR,	A. L. KNISLEY,
G. A. SMITH,	J. L. STONE,	C. E. HUNN,
W. W. HALL,	MRS. A. B. COMSTOCK,	H. B. CANNON.

REPORT.

His Excellency, the Commissioner of Agriculture of the State of New York, Albany, N. Y.

SIR :—

I have the honor to transmit herewith the tenth annual report of the Agricultural Experiment Station of Cornell University, in accordance with the Act of Congress of March 2, 1887, establishing the Station.

While the investigations of the Station are all believed to be of great value, and the fourteen bulletins issued during the last six months are each and all worthy of note, I may be permitted to call special attention to the work in furtherance of scientific agricultural investigation carried on under Chapter 128 of the Laws of the State of New York for 1897. Through teachers' leaflets and similar means an attempt is being made to prepare the farmers of the State of New York for intelligent and helpful co-operation in the experiments carried on by the Station ; and at the same time to carry on extensive experiments under the varying conditions of climate and soil which obtain in the different portions of the State. These experiments are at present in three lines, sugar beet culture, horticulture and the use of commercial fertilizers, and it will be readily seen from the maps accompanying this report, on how large a scale these experiments have been planned. I cannot but believe that the capabilities of the Station will by these means be enormously increased.

I have the honor to be your obedient servant,

J. G. SCHURMAN,
President of Cornell University.

REPORT OF THE DIRECTOR.

To the President of Cornell University.

SIR:—

The letter of Mr. A. C. True, Director of Experiment Stations, Washington, D. C., hereunto attached, explains why this report is written at this time instead of at the end of the calendar year as has been the custom heretofore. It should be noticed that the financial part of this report covers the fiscal year ending June 30th, 1897; that part of it which relates to the publications and work undertaken covers but six months, January 1st to July 1st, 1897, and hence is not so extended as was last year's report which covered a full calendar year.

The State appropriated (Chapter 128 of the Laws of 1897) $25,000 for "giving instruction by means of schools, lectures and other University Extension methods, or otherwise, and in conducting investigations and experiments; in discovering the diseases of plants and remedies therefor; in ascertaining the best methods of fertilization of fields, gardens and plantations; and best modes of tillage and farm management and improvement of live stock; and in printing leaflets and disseminating agricultural knowledge by means of lectures or otherwise; and in preparing and printing for free distribution the results of such investigations and experiments, and for republishing such bulletins as may be useful in the furtherance of the work; and such other information as may be deemed desirable and profitable in promoting the agricultural interests of the State." This appropriation has made it possible to greatly enlarge the scope of our work and to employ additional help to carry on investigations and instruction in fields not heretofore covered. It has also made it possible to republish several valuable bulletins, which were out of print, for which there is a growing demand.

The work under Chapter 128, Laws of 1897, began in April and has been carried on vigorously up to the present time. Two sets of circulars were prepared and sent out, one in which were

given full directions for conducting culture experiments with sugar beets, selecting land, preparing the soil, planting, tillage, harvesting and preparing specimens for analysis, together with diagrams showing the size, number and arrangement of plats. The Department of Agriculture at Washington furnished the beet seed which was distributed to three hundred and sixteen experimenters. The experiments are being conducted in thirty-four of the sixty counties of the State. The other circular was prepared by the Chemical Department and it, in like manner, gave full directions for carrying out experiments with sugar beets and other crops on plats treated with commercial fertilizers of known weight and composition together with unfertilized check plats. The Station purchased and sent out two hundred and three sets, each set containing five small sacks of fertilizer. These investigations cover forty-seven counties of the State and hence are, as well as those previously mentioned, being carried on under varied climatic and soil conditions.

The farmers of New York know but little about sugar beet culture, soil or fertilizers best adapted to the highest development of the beet. By these extended experiments it is hoped that much useful information will be disseminated and that the farmers will be led to carry on investigations on their own account in the future, while the Station will be able to discover the districts and the kind of tillage and fertilizers which give promise of highest results.

On the University farm twelve plats which are separated from one another and from the adjoining land by cemented brick walls two feet deep, have been planted to sugar beets, with and without fertilizers. Soil to the depth of two feet was removed, eight inches at a time, and placed in three piles. After the walls were built each pile of earth was thoroughly mixed and returned in the reverse order of its removal. It is hoped by this means to secure normal out door conditions while securing absolutely like conditions of soil-texture and composition.

The most difficult and original experiment undertaken is the introduction into the schools of what, for want of a more appropriate name, has been called "Nature Study." For a long

time many educators have seen that there is a great gap in the courses of study offered in the schools above the primary grade. By common consent it is agreed that no more courses can be added and it is not clear what studies, if any, can be omitted, but all agree that the youths of the land should become interested in the plants and animals and other natural objects by which they are surrounded and with which they will have to do in after life. It was found that by conducting the work, not as a study but as a rest exercise for a few minutes each day, great interest was aroused and that instead of adding to the pupil's work, it lightened it and created a desire to become better acquainted with Nature in garden, field and wood. To start this work, leaflets have been prepared by persons especially fitted for the work, these have been printed and distributed, usually to teachers, though in a few cases to the pupils.

Leaflets I., "How a Squash Plant gets out of the Seed;" II., "How a Candle Burns;" III., "Four Apple Twigs;" and V., "Some Tent Makers," have gone to a third edition; Leaflet IV., "A Children's Garden," for pupils and teachers, to a fifth edition; Leaflet VI., "What is Nature Study," to a second edition, and twenty thousand copies of Leaflet VII., "Hints on Making Collection of Insects," were issued June 1, 1897.*

Mr. John W. Spencer and Mr. John L. Stone, have conducted the Extension work and some of the experiments in the western half of the State. Mr. George T. Powell and Miss Mary Rogers have conducted like work in the eastern half of the State. Mr. George A. Smith and Mr. W. W. Hall have conducted the instruction in dairy husbandry throughout the State.

These three groups of experimenters and instructors have been assisted from time to time by the professors and instructors of the College and Station and by a few special helpers not connected with the University. Honorable Charles R. Skinner, Superintendent of Public Instruction, and Honorable Charles A. Wieting, Commissioner of Agriculture, have given us hearty and efficient support.

---

* For a sketch of the origin and progress of the Agricultural Extension Work see Cornell Bulletin 137, May, 1897.

The majority of farmers are anxious to secure a better and more extended understanding of their profession. They are difficult to reach because they had no training in their special occupation while in school, and not because they are unwilling to learn. It is humiliating to look over the courses of study offered to farmers' children and see what scant and poor provision has been made for teaching anything which has a direct relation to tilling the soil or for giving any inspiration which might help them to discover the laws which govern the soil, the plant and the animal. This Extension work in Nature Study is as yet an experiment. Its aim is primarily to reach and help the teachers and through them the farmer with the hope and expectation that the pupils and their parents will be taught both useful and interesting facts and that they will come to see the need of investigating for themselves. Each farm and each crop has its own problems to be solved, the Experiment Stations can give valuable assistance, but climate, soil plants and conditions vary so widely that the farmer who desires to reach better results must experiment for himself. It is believed that the Extension work has materially assisted in securing the hearty co-operation of more than five hundred farmers in the experiments which are being carried on throughout the State.

The first object in issuing leaflets on Nature Study is to promote investigation, to arouse enthusiasm, to open the eyes of pupils and parents, in order that the future tillers of the soil may become better acquainted with Nature's laws and modes of action, thereby enabling them to direct Nature's laws so intelligently as to produce highest results.

Until the middle of this century no instruction nor real help had been offered to the tillers of the soil, so it is no wonder that the very foundations of scientific, applied and experimental agriculture are yet to be laid in the schools, or that the term "Nature Study" is selected in order to make agricultural instruction popular.

Fourteen bulletins embracing three hundred and thirty-three pages have been issued during the last six months on the following subjects:

No. 124, The Pistol-Case-Bearer in Western New York.

No. 125, A Disease of Currant Canes.

No. 126, The Currant-Stem Girdler and The Raspberry-Cane Maggot.

No. 127, A Second Account of Sweet Peas.

No. 128, A Talk About Dahlias.

No. 129, How to Conduct Field Experiments [with Fertilizers.

No. 130, Potato Culture.

No. 131, Notes upon Plums for Western New York.

No. 132, Notes upon Celery.

No. 133, The Army-Worm in New York.

No. 134, Strawberries under Glass.

No. 135, Forage Crops.

No. 136, Chrysanthemums of 1896.

No. 137, Agricultural Extension Work: Sketch of its Origin and Progress.

Circular No. 5, Concerning Co-operative Tillage Experiments.

Circular No. 6, Directions for the Application of the Fertilizers and Records to be made.

Brief reports of the progress of the work in charge of the various divisions of the Station and the Treasurer's report are hereunto appended, together with a detailed and classified report of receipts and expenditures for the fiscal year ending June 30, 1897.

Assistant Professor of Dairy Husbandry H. H. Wing has been given a leave of absence for nine months, and is now in Europe, making an extended study of the dairy industries of England, Holland, Sweden and Denmark. Therefore no report of progress in dairy husbandry is submitted. It may be said that extended investigations have been and are being conducted along dairy lines, the results of which will be published in the early part of next year.

Some extended investigations have recently been instituted by the Veterinary Division of the Station for the purpose of securing a fuller knowledge of the causes of contagious abortion in milch

cows in hopes that with a clearer understanding of causes a remedy may be discovered for this disease which has been so prevalent during the last quarter of a century and which has caused more loss in the dairy than all other diseases combined.

Reports which have reached us from many parts of the State during the last year indicate that the mortality among swine has been unusually large, due to causes which have not yet been discovered. Experiments have been begun with a view of determining the cause and remedy for this trouble.

The force of the Station has been doubled during the last two years, many investigations and experiments along lines which bear upon nearly every agricultural industry of the State are being vigorously prosecuted and the Station staff is working harmoniously and enthusiastically for a common purpose—the advancement of those industries which are embraced under the generic term "Agriculture."

I. P. ROBERTS.

UNITED STATES DEPARTMENT OF AGRICULTURE,
OFFICE OF EXPERIMENT STATIONS,
WASHINGTON, D. C.

June 29, 1897.

Dear Sir:—

The experiment stations in 15 States now make the annual reports of their operations as well as their financial reports cover the fiscal year ending June 30. Now that this Department is required to make a report to Congress on the work and expenditures of the Stations for each fiscal year, it would be better as far as we are concerned if it was the uniform practice of the Stations to make their annual reports for the fiscal year. There is nothing in the Hatch act to forbid this. That act simply calls for an annual report without defining exactly the period to be covered.

If we could receive the report of the work and expenditures of all the Stations by September 1, it would enable us to make our report to Congress at the opening of the session in December. It would then receive proper consideration by the committees in connection with the appropriation bill. As it is now, the information available for these committees is a year old when the report is considered and may unfairly represent the condition of affairs at a number of the Stations at that time.

Very truly yours,

A. C. True, Director.

REPORT OF THE CHEMIST.

To the Director of the Cornell University Agricultural Experiment Station.

SIR :—

The following is a report of work done in the Chemical Laboratory between July 1, 1896, and June 30, 1897.

Name.	Analyzed for	Number of Samples.
Soils	Water	47
Soils	Nitrogen, phosphoric acid and potash	7
Fodders	Fodder analysis	34
Fodders	Nitrogen, phosphoric acid and potash	3
Celery plants	Nitrogen, phosphoric acid and potash	10
Apple tree leaves	Nitrogen, phosphoric acid and potash	3
Urine of horse	Phosphoric acid	8
Grapes	Acid and sugar	20
Sugar beets	Sugar	4
Potatoes	Nitrogen and starch	4
Clover roots	Nitrogen	4
Clover tops	Nitrogen	3
Clover nodules	Nitrogen	1
Paris green	$As_2 O_3$ (arsenic trioxide)	2
Ashes	Phosphoric acid and potash	1
Commercial K salts	Potash	2
Water	Lime, magnesia and potash	1
Manure	Nitrogen, phosphoric acid and potash	1
Callerine		1
		156

In addition the A. O. A. C. work was done on potash.

G. C. CALDWELL.

REPORT OF THE BOTANIST.

July 1, 1897.

Professor I. P. Roberts, Director.

DEAR SIR:—

I have the honor to present the following report of the Botanical Division of the Experiment Station for the past six months.

There have been published two Bulletins during the year, as follows: A Disease of Currant Canes, Bulletin 125, February, 1897, by E. J. Durand, assistant botanist during the previous year. Two Destructive Celery Blights, by B. M. Duggar, assistant botanist. These articles were published in Bulletin 132, March, 1897.

Work is in progress upon the following subjects: A very thorough study has been made of several of the parasitic fungi known as anthracnoses which attack fruits and various vegetables. The matter is being prepared for a bulletin but considerable time is necessary to complete it because of the numerous illustrations. It is hoped, however, to present it sometime during the coming autumn.

A great deal of attention is being given to the preparation of illustrations in the way of fine photographs of the larger fungi known as mushrooms, with a view to publishing a series of bulletins on the edible, poisonous and indifferent species in the State, for the purpose of arousing an interest in the value for food of the edible species and to give simple directions for becoming acquainted with the more common species.

Studies are also in progress on the diseases of timber and forest trees, and already many valuable illustrations have been made for future bulletins of an educational character, as well as of scientific value.

In connection with this, investigations have been begun upon the development and embryology of certain of the forest trees, especially, at present, the pines and other conifers, with a view to determining rate of growth, distribution, fertility of seed, as well as the conditions which influence or modify the life of these trees.

Mr. B. M. Duggar, the assistant botanist, is engaged upon several lines of investigation. Practical and scientific studies are being made by him of certain celery diseases, and of the leaf spot of the pear. Other investigations are being started which will lead to important results it is hoped. Beside the work of investigation and of instruction which Mr. Duggar is carrying on, the correspondence is constantly increasing in reference to diseases of various kinds which attack fruits, vegetables, etc., so that a considerable part of his time is taken up with these matters.

The work of the year besides the results of the investigations has added materially to the equipment of the Division in the way of illustrations, negatives, etc., besides the additions to the apparatus by purchase.

Very respectfully yours,

GEO. F. ATKINSON,

Botanist.

REPORT OF THE ENTOMOLOGIST.

To the Director of the Cornell University Agricultural Experiment Station.

SIR :—

As the carrying out of the Entomological work of the Station has been performed during the past six months almost entirely by the Assistant Entomologist, I have requested him to prepare a report on it, which I hereby transmit.

Very respectfully yours,

JOHN HENRY COMSTOCK,

Entomologist.

To the Entomologist of the Cornell University Agricultural Experiment Station.

SIR :—

During the period covered by this report (from January 1st, 1897, to July 1st, 1897), the work of the Entomological Division of the Station has been along the same lines as in previous years, but it has been of a somewhat different nature in some respects. Thus far, the year 1897 has been quite a remarkable one in New York State, so far as the prevalence of insect life is concerned. Many of our common insect pests which are more or less destructive every year have been conspicuously numerous and injurious, while some other insects which usually harass the fruit grower every year have attracted attention to themselves by their absence or non-occurrence in injurious numbers.

In the former class are to be mentioned plant-lice, which have been much more numerous and destructive on many different kinds of vegetation all over the State than for many years before ; canker worms have again ravaged many acres of apple orchards in the western part of the State; in May and June, thousands of apple and wild cherry trees all over the State bore the unsightly tents

of the common apple-tree tent caterpillar (*Clisiocampa americana*), and many of the trees were entirely stripped of their foliage by the ravenous hordes of these caterpillars; at the present time (July 1st), the forest-tent caterpillar (*Clisiocampa disstria*) is ravaging acres of shade and forest trees in several parts of the State (it was mistaken for the gypsy moth in Delaware county); the pear psylla has again appeared in immense numbers in many pear orchards and the crop of fruit is seriously threatened. On the other hand, however, as we predicted in Bulletin 133, the army-worm seems not to have attracted attention anywhere in the State this year, although thousands of armies of the worms ruined thousands of acres of field crops last year; many of the larger plum growers in the State have been agreeably surprised this year to find that their old and dreaded enemy—the plum curculio—did not appear in numbers sufficient to make it necessary to go to the trouble and expense of fighting it; one of our largest quince growers also writes that the quince curculio (*Conotrachelus crataegi*) also appeared in surprisingly small numbers this summer; we had intended to begin a critical study of the life-history of white grubs this spring but were unable to find enough of the May beetles to start the experiment; for two or three years the crops of New York farmers have suffered from hordes of grasshoppers, but this year, doubtless owing to the work of their enemies and to climatic conditions, grasshoppers appear to be scarce in many localities.

Thus the year 1897 has thus far been one of peculiar interest, from an entomological standpoint, in New York. The facts given in the above paragraph have been brought out by our extensive correspondence and by personal observations while engaged in lecture work under the auspices of the Nixon Bill.

No new outbreak of any insect pest has thus far occurred which seemed to necessitate carrying on extensive experiments at the insectary in the study of its habits or methods of combating it. Our time has been fully occupied in continuing work that was begun last year or in previous years, also in preparing some of last year's results for publication, and in attending to the mass of correspondence arising from the sudden and unusually destructive outbreaks of the well-known insect pests mentioned above.

However, as the quince curculio was so destructive last year in some localities as to lead growers to seriously consider the advisability of cutting down their orchards, we have taken up the critical study of its habits this year and hope to be able to reach some practicable conclusions regarding methods of controlling such a serious pest.

The following bulletins have been published from this Division during the past six months:

No. 124, The Pistol-Case-Bearer.

No. 126, The Currant-Stem Girdler and the Raspberry-Cane Maggot.

No. 133, The Army-Worm in New York.

Our inability to get the results of our last year's study of the codlin moth ready for publication in the spring has enabled us to verify our observations this year; our conclusions will soon be put in shape for publication as a bulletin. The results of our last year's applications in our extensive peach borer experiment have just been ascertained, and they reveal some striking and valuable facts which will add much definite data to our knowledge of how to fight this serious peach pest. We expect to be able to collate and digest the details of our work with this insect which have accumulated during the past three years, and get the conclusions ready for publication during the coming year.

Our endeavor to give each correspondent the latest and best information at our command results in a rapid increase in the correspondence of this Division. About five hundred queries were answered during the past six months; fifty of these were prepared for publication in agricultural journals. The fact that we are thus often enabled to reach special and urgent cases quickly, renders the correspondence of this Division one of the most valuable and important features of its work. We have also published several technical articles in entomological journals.

Respectfully submitted,

M. V. SLINGERLAND,

Assistant Entomologist.

REPORT OF THE AGRICULTURIST.

To the Director of the Cornell University Agricultural Experiment Station.

SIR :—

Since my last report to you two bulletins have been published by the Department, No. 130, Potato Culture, and No. 135, Forage Crops. These bulletins give the results of experiments extending over a period of two years. To verify the results published, the experiments are being repeated this year and the results will probably be published as a supplementary bulletin. An interesting line of work, and one which now promises well, is the intro-culture of grain crops. For three years the experiment has been conducted with wheat and this year it has been extended to oats. A question which is seriously puzzling the farmers of the State is how they can best control the wild carrot, the mustard and the cress, all of which have been abundant in the oat fields the past season. We believe that a practical solution of the question will be found in intro-culture. It remains now to have manufactured some implement so that the work can be performed cheaply and efficiently by horse-hoe tillage.

The study of leguminous plants and their comparative value as nitrogen gatherers, commenced last year, is being continued. An effort is being made to determine what portion of the nitrogen stored up by the clover plant is actually taken from the atmosphere and what from the soil. The investigation in connection with this work will necessarily have to be extended over a series of years.

Certain leguminous plants which in their native soil and climate produce root tubercles have been found not to produce them here. By a system of soil inoculation it is hoped that these nodules or tubercles may be induced to grow and that

we may thus add to the list of our valuable nitrogen-gathering leguminous plants.

In the spring of 1896, one thousand white ash seedlings were set in the University woodland. These seedlings were purchased and set at a total cost of only two cents each. From seventy-five to eighty per cent. of them are now living and making good growth. The result of this experiment so far would indicate that much of the hilly land unfit for cultivation could far more profitably be devoted to forestry.

Many causes have combined to awaken an interest in the manufacture of beet sugar. This department is conducting extensive experiments to determine whether the beets can be profitably grown in this State, what system of tillage is best, and what fertilizers are required to give the highest per cent. of sugar. Beet seed, with directions for planting the same and caring for the product, have been sent to over three hundred farmers who are co-operating in the experiment. The work with sugar beets at the home grounds this year is mainly in determining what fertilizers give best results both as to yield, sugar content and purity.

The work of the Division is largely confined to lines of investigation which are practical in their nature, and an attempt is being made not only to discover new truths but to emphasize and enforce old ones, and to show plainly that success in agriculture depends largely upon improved practices and methods of tillage.

Respectfully submitted,

L. A. CLINTON,

Assistant Agriculturist.

REPORT OF THE HORTICULTURIST.

To the Director of Cornell University, Agricultural Experiment Station.

SIR:—

In the absence of Professor Bailey, I can make only a partial report of the progress of work in this Division from January 1st to July 1st, 1897.

Of the out-door work the successful contest with the San José scale is perhaps the most pressing for early publication. Two thorough and timely sprayings with kerosene and water, in a combination of one part to four, saved all the kinds of shrubs treated, and we have not seen a live insect since. This experience has brought out a number of points which will doubtless be welcome news in the midst of the general anxiety. Among the tree fruits, progress has been made in the permanent orchards which were devoted to carefully planned and far reaching fertilizer experiments. Some new varieties of Japanese plums are fruiting for the first time and the Station is fortunate in having the expert services of Mr. S. D. Willard, of Geneva, in judging the varieties of this popular new type of plums. A new vineyard has been set and important accessions made. The work in small fruit culture has consisted largely of local fertilizer experiments in six strawberry fields of Oswego county, the results of which are very gratifying and of great general interest. Two beds of strawberries have been set, one of new varieties, and one to continue the in-door work. In vegetable gardening we are in the midst of our second year of investigations with celeriac and Brussels sprouts. An acre of celery has also been planted on the onion meadows of Orange county in an attempt to introduce the culture of this crop within easy shipping distance of the large eastern markets. In floriculture the work is confined to studies of cannas, dahlias,

and to the vexed problems concerned in the forcing of Bermuda lilies for Easter, and to chrysanthemums.

The indoor work now looks toward a long series of cultural experiments in the forcing of fruits; collections of apricots, peaches and cherries are ready, and as soon as the proper facilities are at hand the growing of grapes from a commercial standpoint is to be undertaken. One of the smaller greenhouses has been remodelled for a strawberry forcing house to follow up the successful work of last winter, reviewed in Bulletin 134.

Very respectfully submitted,

C. E. HUNN, in charge.

REPORT OF THE TREASURER.

The Cornell University Agricultural Experiment Station, in account with the United States appropriation, 1896–7.

	Cr.	Dr.
To Receipts from Treasurer of the United States as per appropriation for fiscal year ending June 30, 1897, as per Act of Congress, approved March 2, 1897		$13,500 00
By Salaries	$ 8,043 75	
Labor	1,988 57	
Publications	299 60	
Postage and Stationery	251 05	
Freight and Express	118 75	
Heat, Light and Water	63 84	
Chemical Supplies	147 49	
Seeds, Plants and Sundry Supplies	651 37	
Fertilizers		
Feeding Stuffs	164 83	
Library	108 22	
Tools, Implements and Machinery	56 95	
Furniture and Fixtures	126 68	
Scientific Apparatus	772 82	
Live Stock	301 10	
Traveling Expenses	145 88	
Contingent Expenses	10 00	
Building and Repairs	249 10	
		13,500 00

We, the undersigned, duly appointed auditors of the corporation, do hereby certify that we have examined the books and accounts of the Cornell University Agricultural Experiment Station for the fiscal year ending June 30th, 1897; that we have found the same well kept and classified as above, and that receipts for the year from the Treasurer of the United States are shown to have been $13,500.00, and the corresponding disbursements $13,500.00, for all of which proper vouchers are on file, and have been by us examined and found correct, thus leaving no balance on hand.

And we further certify that the expenditures have been solely for the purpose set forth in the Act of Congress approved March 2, 1887.

(Signed) H. B. Lord, Geo. R. Williams, } Auditors.

(Seal)

Attest: Emmons L. Williams,
Custodian.

APPENDIX I.

BULLETINS PUBLISHED JANUARY–MAY, 1897.

CIRCULARS.

Bulletin 124. **January, 1897.**

Cornell University Agricultural Experiment Station.

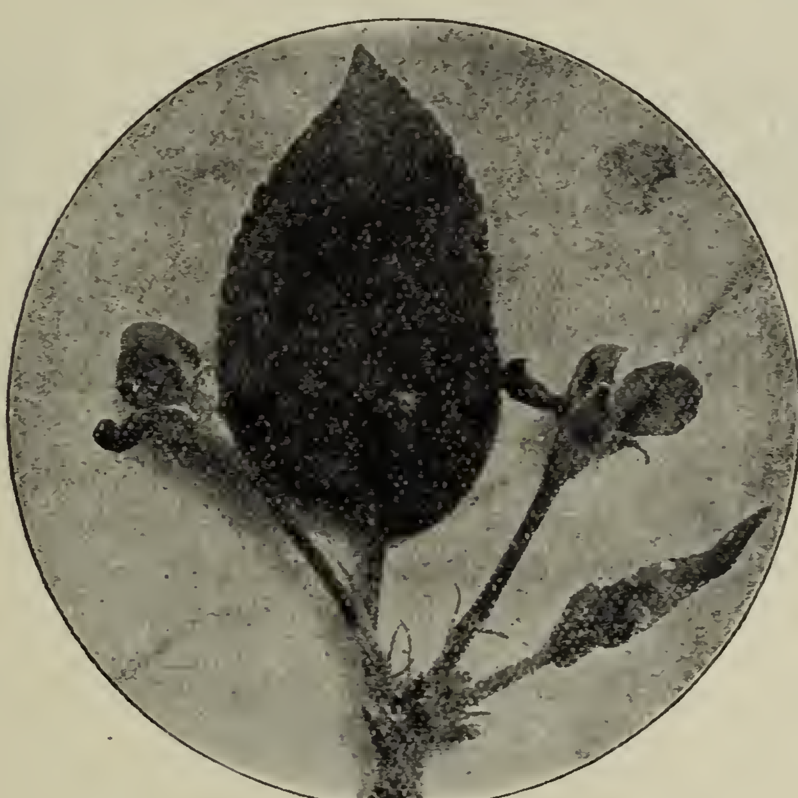
ITHACA, N. Y.

ENTOMOLOGICAL DIVISION.

The Pistol-Case-Bearer

—IN—

Western New York.



By M. V. SLINGERLAND.

ORGANIZATION.

BOARD OF CONTROL:

THE TRUSTEES OF THE UNIVERSITY.

STATION COUNCIL.

President, JACOB GOULD SCHURMAN.

Hon. A. D. WHITE,	Trustee of the University.
Professor I. P. ROBERTS,	President State Agricultural Society.
Professor I. P. ROBERTS,	Agriculture.
Professor G. C. CALDWELL,	Chemistry.
Professor JAMES LAW,	Veterinary Science.
Professor J. H. COMSTOCK,	Entomology.
Professor L. H. BAILEY,	Horticulture.
Professor H. H. WING,	Dairy Husbandry.
Professor G. F. ATKINSON,	Botany.

OFFICERS OF THE STATION.

I. P. ROBERTS,	Director.
E. L. WILLIAMS,	Treasurer.
E. A. BUTLER,	Clerk.

ASSISTANTS.

M. V. SLINGERLAND,	Entomology.
G. W. CAVANAUGH,	Chemistry.
L. A. CLINTON,	Agriculture.
B. M. DUGGAR,	Cryptogamic Botany.

Office of the Director, 20 Morrill Hall.
The regular bulletins of the Station are sent free to all who request them.

BULLETINS OF 1897.

124. The Pistol-Case-Bearer in Western New York.

CORNELL UNIVERSITY, ITHACA, N. Y., January 1, 1897.

THE HONORABLE COMMISSIONER OF AGRICULTURE, ALBANY.

Sir :—The following paper considers another of the many insects which contribute their share towards making fruit-growing a scientific business. The observation of any insect and the study of truthful descriptions of it, are direct means of education ; and the final mastery of it is a means of encouraging and fortifying the farmer in every adversity. This bulletin, therefore, has two distinct merits,—the imparting of immediate information concerning the pest, and the power of inspiring correct and hopeful habits of thought; it is therefore submitted for publication under Chapter 437 of the law designed to extend the experiment station method and work.

L. H. BAILEY.

THE PISTOL-CASE-BEARER.

Coleophora malivorella Riley.

Order LEPIDOPTERA ; superfamily TINEINA.

Among the most interesting insects that trouble the fruit grower are those known as "case-bearers ;" thus named from the fact that in their destructive stage they are encased in curiously-shaped suits which they wear wherever they go. One of these insects, the cigar-case-bearer, has done much damage in western New York orchards since 1893 ; it was illustrated and discussed in Bulletin 93. During the past year another case-bearer appeared in large numbers in several apple orchards in western New York and proved even more destructive than the cigar-case-bearer. Frequently both kinds of these case-bearers and the bud-moth (Bulletin 107) worked together on the same branch.

In 1896, many New York farmers and fruit-growers became acquainted for the first time with several insects which seemed to have suddenly appeared in their field crops or orchards in destructive numbers. The army-worm, the green fruit worms (Bulletin 123), and the case-bearer under discussion, are illustrations of this fact. To many, these insects were new pests ; and it is a remarkable fact that, although all of them have occurred in our state for many years and have at times been injurious, it has been nearly fifteen years since any of them appeared in sufficient numbers to do noticeable injury.

HISTORY, DISTRIBUTION, AND FOOD-PLANTS OF THE INSECT.

This pistol-case-bearer is an American insect, and first attracted attention in 1877 in a large apple orchard of over 8000 trees in Erie County in Pennsylvania. The owner of this orchard reported that it seemed as if there was one on each bud on almost every tree in the orchard ; the next year the insect was still more destructive, rendering large numbers of trees nearly leafless. Specimens of the insect were sent to Dr. Riley, and in 1879, he published (Ann. Rept. of Com. of Agr. for 1878, p. 253) a brief

illustrated account of the pest, describing and naming it as new to science. Scarcely anything new has been recorded about the insect since. What was doubtless the same case-bearer was recorded from Kentucky in 1878, and was found upon chestnut bark near Ithaca, N. Y., in 1880. In the spring of 1882, the insect did considerable damage in apple orchards at South Byron, N. Y. It did not again attract serious attention in New York state until 1896. In 1891, a few specimens were sent to Dr. Lintner from Lansing, Oswego Co., and Walworth, Wayne Co., and the same year we found some of the cases on a wild cherry tree near the insectary. The insect was reported as occurring in Nebraska and adjoining states in 1894, and we received a few specimens from Sodus, Wayne Co., N. Y., the same year. In 1895, it was found in Canada and in New Mexico. During the past year, the insect did much damage in large apple orchards at Geneva and at Walworth, N. Y. We also received it from Clarkson, Monroe Co., N. Y. It has been recorded from New Jersey as common on apple, plum and cherry.

Thus the insect has quite a wide range of food-plants, including the three orchard fruits just mentioned, and probably the chestnut. It is also widely distributed over the country, occurring from Canada southward through New York and Pennsylvania and westward through Nebraska into New Mexico. It has been injurious only in New York and Pennsylvania. Nothing can be predicted as to its future.

How distributed.—It is claimed that the pest was introduced into the far west on eastern nursery stock. This is doubtless by far the most fruitful source for the distribution of the insect.

ITS APPEARANCE.

On account of its small size and peculiar habits, the insect itself in any stage, will rarely be noticed by the fruit-grower. But one of the curious suits, or cases as they are called, which the little caterpillar wears, is quite conspicuous, thus often revealing its presence to the casual observer.

The caterpillar and its curious case.—The insect is destructive only in its caterpillar stage, and yet the fruit-grower usually sees only the peculiar suit or case worn by the caterpillar. Several of

these curious cases with their inhabitants partly protruding from one end are shown much enlarged at *b*, *b*, *b*, plate 1; at *c*, plates 1 and 2, many of the cases are represented, natural size, attached to the branch. The cases are of a dark brown or black color, more or less covered with grayish pubescence from the leaves. Their form is aptly described by the word "pistol-shaped." They are of a tough leathery texture, and evidently made of silken threads interwoven with the pubescence from the leaves, and the whole stained dark in some manner, probably by the excrements of the caterpillar. How this curious case is made will be described further on in discussing the life history of the insect. When the insect is at work in April, May, or June, these curious pistol-shaped cases are quite conspicuous, and certainly very odd-looking objects, as they are seen projecting at various angles from a flower-bud (frontispiece), from the surface of a leaf, or from the side of a branch (*c*, plates 1 and 2). They are sure to arouse one's curiosity, especially when, after watching one for a few minutes, it is seen to move off to another part of the bud or leaf.

1.—*Work of the pistol-case-bearer on apple foliage. Natural size.*

A careful examination of one of these moving pistol-shaped objects will reveal its inhabitant, an orange-colored, black-headed caterpillar about one-fourth of an inch in length.* When dis-

*Technical description of larva.—Length, 6 mm. Color, deep chrome or light orange; the thoracic segments are darker, the first one blackish.

turbed the little creature retreats into its pistol-shaped case and can be induced to come forth only by either tearing open its case, or by continued urging from the rear.

The adult insect.—The moth is a very delicate and pretty little creature. It is represented nearly four times natural size at *a*, *a*, plate I; the male moth, which is considerably smaller, is shown in the lower of the two figures, and the larger female in the upper figure. They are of a general dark drab color; on the basal third of the front wings white scales predominate in the females, but are sometimes almost entirely lacking in the males. The alternation of the rings of dark and white scales give the antennæ and legs a curious annulated appearance. The basal joint of each antenna in both sexes bears a conspicuous tuft of scales, those of the female being considerably larger.* All of these characteris-

---

Head, black with a yellow median suture; antennæ, yellow. Thoraci segments each with a blackish, granulate, chitinous spot on the lateral ridge; the mesothoracic segment has besides two similar, narrow, triangular, black, transverse spots, separated by a narrow yellow mesal line near its caudal border, and there is a similar subdorsal black spot on each side near the cephalic margin; the thoracic shield is large, black, and nearly divided by a narrow yellow median stripe. The anal shield is also black. The true legs are black, with the distal segment and the extremities of the other segments yellowish. The four pairs of pro-legs are of the same color as the body, except the anal ones which are slightly darker and have a large black spot near the base of each. The whole surface of the body is granulated, more strongly so on the thoracic and anal segments. A few hairs arise from the head, thorax and anal segment.

This description, taken from full-grown living specimens of the caterpillars differs considerably from Dr. Riley's description in his report for 1878. None of the caterpillars that Dr. Riley had, seem to have been preserved, so that we cannot explain these striking differences.

*In his description of the moth (Ann. Rept. Com. of Agr. for 1878, p. 254), Dr. Riley states that the males have no tuft on the basal antennal joint; he describes the tufts of the females. How this mistake occurred is not known. Mr. L. O. Howard, U. S. Entomologist, writes me as follows: "There are ten specimens of *Coleophora malivorella* in the National Museum collection. Five of these are males and five are females. The tuft on the basal joint of the antennæ occurs in *both* sexes, but is a little longer in the females than in the male. One of these males has lost the tuft entirely and in another is partly gone. It was also completely lost in one of the females.

All of these ten specimens are from the original 1878 rearings. Dr. Riley probably examined the single male which had lost the tuft."

PLATE II.—*The pistol case-bearer* (*Coleophora malivorella* Riley). a, *destructive work of the insect on apple blossoms, natural size;* b, b, *cases showing recent white additions at the ends, much enlarged;* c, *full-grown case-bearers attached to the branches for pupation, natural size.*

tics are shown in the figures at *a*, *a*, plate 1. The general color of the males is slightly darker, especially the head.

During the day the moths rest on the leaves and branches with their heavily fringed wings folded closely over the abdomen and their long, slender antennae placed close together and projecting straight forward from the head. They may be seen in this position on the trees in June.

ITS NAME.

This case-bearer belongs to the large group of minute moths known as Tineids. Nearly all the Tineids are easily distinguished from the other moths by their narrow wings which are bordered with very wide fringes (see figure *a*, plate 1). The name *Coleophora malivorella*, by which the insect is recognized among scientists the world over, was given to it by Dr. Riley in his report as U. S. Entomologist for 1878 (published in 1879).*

The popular name of "apple coleophora" given to the insect by Dr. Riley was soon superceded by Dr. Lintner's name, "the apple-tree case-bearer." While it is true that it seems to prefer the apple as a food-plant, there are several other case-bearers which feed upon the apple tree, and one of these—the cigar-case-bearer (Bulletin 93)—is even more common and destructive than the one under discussion. We therefore propose the much more definite and descriptive popular name of "the pistol-case-bearer" for the insect. The striking resemblance of the case, which the caterpillar carries about with it, to a pistol makes this popular name especially suggestive to the fruit-grower.

THE STORY OF ITS LIFE AND HABITS.

This interesting little pistol-case-bearer has been under almost

---

* In Bull. 1, Vol. IV, p. 93 of the U. S. Geol. Survey, published February 5, 1878, Mr. V. T. Chambers described *Coleophora multipulvella*. In 1882, Lord Walsingham placed this species in the synonymy of *C. malivorella*, stating that Chamber's description applied to Dr. Riley's specimens, but that the former's type of *C. multipulvella* was not examined. Should Chamber's type specimen prove to be Dr. Riley's *C. malivorella* the last name must fall, on the ground of priority of publication, and the pistol-case-bearer be called *Coleophora multipulvella*. If Chamber's type is still in existence this point could be easily settled by some one familiar with the Tineids.

daily observation here at the insectary from the time it awoke from its winter's sleep in April, 1896, until it passed through its wonderful transformations into the pretty little moth, from whose beautiful and oddly-shaped eggs the little caterpillars hatched in the fall and soon made their preparations for their long winter's rest. While its life history is similar to that of the cigar-case-bearer (Bulletin 93) its habits are quite different and present several interesting phases of insect life.

How it passes the winter.—In our cages the little creatures began to go into winter quarters as early as August 26th ; they were then minute, less than half-grown, orange-yellow caterpillars, encased in very small pistol-shaped suits, which were firmly attached to the bark, usually on the smaller branches. These hibernating cases are about one-half as large as those shown natural size at *c*, plate 1, and they are shaped like the much enlarged case shown at *b* in the extreme upper right-hand corner of plate 1. Where the insect is quite numerous, it may be easily found in its winter quarters.

About seven months of the pistol-case-bearer's life is spent in idleness in its snug little case on the twigs of the trees.

Its spring appearance and habits.—The little caterpillars awake from their long winter's fast very early in the spring, as soon as the buds begin to swell. In 1896, the little cases were loosened from the twigs soon after April 1st, and the march of the hungry caterpillars for the buds began ; by April 15th, they were at work in full force on the buds. By eating or boring small holes, scarcely larger than a pin in the swelling fruit and leaf buds, the little creatures did much damage very early in the season. On April 24th, we examined the large orchards of Messrs. Yeomans, at Walworth, N. Y., and found the pistol-case-bearers so thick in one apple orchard that it seemed as though there was one case to every two or three buds on the trees ; the buds were just beginning to open.

As the caterpillars continue feeding on the opening buds, they soon find that their winter suits or cases are too small for their growing bodies ; and they proceed to build on extensions at both ends and along the lower edge.

Its pistol-shaped suit.—Unlike the cigar-case-bearer (Bulletin 93)

the pistol-case-bearer does not construct an entirely new and larger suit to accommodate its increasing size. It simply pieces on additions to its suit from time to time. In the enlarged cases represented at *b*, *b*, plate 2, the white portion at the head end is a very recent addition to the case; the right-hand figure also shows a slight addition around the anal orifice. We have specimens of cases which show fresh, white additions all along the lower edge of the case as well as at both ends. These additions seem to be made mostly of silk in which is mixed considerable of the pubescence and *debris* of the leaves, and the whole is glued together to form a tough leathery substance. Although white when first made, the additions soon become stained a very dark brown, perhaps from the excremental or other juices of the caterpillar. After about May 1st, the caterpillars seem to confine nearly all of their extensions to the head end of their suits, thus considerably lengthening the barrel of the "pistol." When complete then, their cases are simply their first winter suit that has been made larger around and longer by additions or patches put on to one side and both ends. Externally the cases or suits present a rough, fuzzy, somewhat untidy appearance, but cut one of them open and take a peep inside. The whole suit is found to be lined with a thin, smooth, whitish, delicate layer of silk which gives the interior a neat, cozy appearance.

The curved end which forms the handle of the "pistol" consists of two flattened oyster-shell-like projections of the suit, which are not joined together along their lower edges, and thus form a slit-like opening that is the back-door to the case. The elasticity of the material and the peculiar curve of this portion of the suit tend always to keep this opening closed. It would require considerable force for an *outside* enemy to open this orifice, though from the inside the slightest pressure enables the caterpillar to protrude its anal segment whenever its excrement is to be voided. This arrangement enables the little caterpillar to keep his snug home neat and clean inside. This back-door also serves another important purpose in the life of the insect, as we shall see later.

Moulting of the caterpillar.—On April 26th, we were surprised to find that most of the caterpillars at work in our cages had securely fastened their cases to the bark of the twigs as shown at

c, plate 1. On May 1st, Messrs. Yeomans, Walworth, N. Y., wrote me that the insects had also done the same thing in their orchard. It seemed hardly possible that they had finished their destructive work thus early, and were preparing to undergo their further transformations. Cases were detached and examined every day, and no explanation was found for the curious preceedure until the fourth or fifth day. Then the cases began to move, and at each spot where a case was fastened there remained attached to the bark the anchor, a minute cup or button of silk, and on each of these we found the cast skin of the head of the caterpillar. This meant that the cases had been fastened to the twigs so that the caterpillar could shed off, undisturbed, its old skin that had become too small, and could then come forth clad in a new and elastic skin that had been growing under the old one. All caterpillars moult or shed their skin several times; it is the way they grow. Doubtless the pistol-case-bearer moults at least three or four times during its life as a caterpillar, and perhaps in the way just described. Apparently the moult which occupied the last four days of April, 1896, was the last one; its occurrence in the heighth of the feeding season rendered it quite conspicuous.

Its feeding habits on the flowers and leaves.—Beginning on the swelling buds, as described on a previous page, the case-bearers continue their destructive work on the opening leaves and flowers. They now feed quite differently from the cigar-case-bearers, which mined out the tissue between the two skins of the leaves. The pistol-case-bearers either devour the whole leaf or all of it but the lower skin and veinlets, thus skeletonizing it, as shown, natural size, in figure 1. The caterpillar never leaves its case, but projects its body out far enough to obtain a good foothold and then begins to eat, holding its case at a considerable angle from the leaf. The cases are thus not attached to the leaf, but move with every motion of the caterpillar as it feeds. While they feed freely on the leaves, they seem to show a decided preference for the opening flowers; this habit makes the insect especially destructive. In the upper part of figure *a*, plate 2, is shown a cluster of flowers which has suffered severely from the attacks of this little foe. It works mostly on the petals of the flowers, but often eats into the stem and soon kills it. Thousands of prospective fruits

were thus "nipped in the bud" in the orchards where the insect worked. After the opening flowers are destroyed or the petals have fallen, the caterpillars turn their attention to the tender foliage. We placed about a hundred of the little cases on a small tree in the insectary that contained no flower-buds. Nearly every leaf on the tree was soon riddled like those shown in figure 1. The insect thus has more destructive feeding habits than the cigar-case-bearer, but as it feeds openly, and does not mine out its food from the interior of the leaf, it would seem to be easier to reach with a poison spray than the latter.

The pistol-case-bearers continued to feed on the leaves until about May 15th, when most of them migrated to the branches where they securely fastened their cases to the bark. Projecting upward from the branches at an angle of about 45 degrees, these full-grown pistol-cases present a peculiar appearance ; this is well shown at *c*, plate 2. So securely are the cases fastened that they often remain on the branches for a year or more, but they are of no further use to the insect after about a month.

Pupation.—After making all secure in the manner just described, the little caterpillar proceeds to prepare for its wonderful transformation to the adult insect—the moth. It first turns around in the case, so that the head is towards the anal opening in the handle of the "pistol." If a case be torn from the bark and carefully cut open about two weeks after it was fastened down, its inhabitant will not be a caterpillar, but a curious light brown, apparently lifeless object—the pupa. This change to a pupa took place about June 7th, in our cages.

The emergence of the moth and egg-laying.—The insect passes from ten to twenty days of its life as a pupa in its old pistol-shaped suit fastened to the branches, as shown at *c*, plate 2. From the curved slit (formerly used as a back-door by the caterpillar) in the under side of the handle of the "pistol," there emerges, from June 17th to the 30th, the adult insect—the pretty little moth described on a previous page and figured at *a*, *a*, plate 1. Thus, the pistol-shaped cases serve as snug warm suits for the caterpillars during their life, and then furnish cozy homes in which the insect undergoes its transformations. Other records give the time of appearance of the moth from the first to the

fifteenth of July, or about two weeks later than our rearings in 1896. This may be accounted for by the fact that the spring of 1896 was a remarkably early one and one also well adapted for the development of insect life; the case-bearers got to work earlier than usual, for the apple buds started nearly two weeks in advance of most seasons.

The moths remain at rest on the leaves during the day, doubtless feeding but little, if any, and doing no damage. Although dozens of moths emerged in our cages during the latter half of June, we found no eggs until July 13th. But the next day, hundreds of them had been laid all over the sides of the cage and on all parts of some apple branches therein. Further observations in the field showed that they were glued fast at their base usually to either the upper or lower surfaces of the leaves. Apparently no one had ever seen the eggs of this case-bearer before, for nothing has been recorded about them.

The eggs are of a cinnamon-rufous color, and are very pretty objects when seen under a microscope. Although they are only .42 mm. (.016 of an inch) in diameter at their base and about .27 mm. (.01 of an inch) in height, they can be seen with the naked eye when one knows where to look and what for. With our micro-camera we succeeded in getting some much enlarged pictures of these curiously shaped eggs; the photographs are reproduced at *d*, plate 1. As the figures show, the eggs remind one of inverted tea-cups with strongly ridged sides. Many fine transverse ridges connect the larger ones, and the deep cavity at the upper end of the egg is quite irregular in shape. They are very different from those of the closely allied cigar-case-bearer. Although a few recently-hatched caterpillars were seen July 14th, most of the eggs did not hatch until a week later; the egg stage thus last about a week in July.

Habits of the recently-hatched caterpillar.—Unlike the cigar-case-bearer, the newly-born caterpillar of the pistol-case-bearer is not a miner, and also begins the construction of its suit soon after it begins to eat. It first eats into the underside of the leaf, making a hole about the size of a pin's head nearly through the leaf. During this first meal, the little caterpillar apparently weaves together with silken threads some of its excrement and a few of

the leaf-hairs, and thus forms around its body a tiny cylindrical case or suit. We have several of these cases that were made July 22, 1896. The caterpillars continue to eat holes in the leaves during July and August, making additions to their suits from time to time and gradually giving them the pistol-shape.

Preparations for winter.—On August 26th, several of the little case-bearers in our cages migrated from the leaves and fastened their cases to the bark of the apple branches. These cases were of the same shape as those shown at *c*, plate 1, but about one-half as large. Doubtless most of the caterpillars stop feeding and fasten their cases to the branches before September 15th. In these snug, warm, and secure quarters the insect passes the winter.

Briefly summarized, the life-history of the pistol-case-bearer is as follows: The insect spends about seven months (from September 1st to April 1st) of its life in hibernation as a minute, half-grown caterpillar in a small pistol-shaped case attached to a twig. In the spring the caterpillars attack the swelling buds, the expanding leaves, and especially the flowers (frontispiece, and figure *a*, plate 2). About May 1st the cases are fastened to the twigs (Fig. *c*, plate 1) where they remain for four days, during which time the caterpillars shed their skin or moult. They do not make any complete new suit as they grow, but are content with making additions (Figs. *b*, *b*, plate 2) to the ends and side of the old suit. They are not miners, but feed openly, eating irregular holes in the leaves, often skeletonizing them. They are most destructive on the flowers where they eat the petals and stems. In the latter part of May, they cease feeding, securely fasten the cases to the branches (Fig. *c*, plate 2) and in about two weeks, change to pupae within. The moth (Figs. *a*, *a*, plate 1) emerges in two or three weeks, and soon glues its minute, pretty, cinnamon-colored, inverted cup-like eggs (Fig. *d*, plate 1) to the surfaces of the leaves. The egg-stage lasts about a week, the little caterpillar emerging about July 22d. They begin eating little holes in the leaves, and during their first meal construct of silk and excrement a small case or suit for themselves. They continue feeding on the leaves, adding to their suits from time to time, until about September 1st, when they begin to migrate to

the twigs and there fasten their little pistol-shaped cases to the bark. The winter is passed in these snug, warm, secure quarters.

NATURAL ENEMIES.

We have not met with any natural enemies of this case-bearer. However, in 1879, Dr. Riley recorded that "the only enemy of this insect, so far as known, is a minute Chalcid fly, which has increased to such an extent since the ravages of the case-bearer became apparent on Mr. Fairweather's place (Erie Co., Penn.) that it bids fair to render additional remedies unnecessary. The specimens sent in 1877 were not parasitized. Those sent in 1878 were about half of them affected, and of twenty-four specimens received in March, 1879, seventeen had been destroyed by this little fly."* It is to be hoped that this little enemy will soon find a congenial home in the western New York orchards where the pistol-case-bearer is so numerous.

HOW TO COMBAT THE INSECT.

It is practicable to fight this case-bearer in its caterpillar stage only; and it is then so well protected in its case as to render its destruction dependent upon very thorough work.

It is very doubtful if any spray will reach the insect in its snug winter quarters. Extensive experiments have shown that the cigar-case-bearer, which winters in a similar manner, cannot be checked by a spray at this time. The only time when the pistol-case-bearer can be effectively reached is when the caterpillars are actively feeding in the spring. As they feed openly upon the buds, leaves, and flowers, and do not *mine* like the cigar-case-bearers, a poison spray thoroughly applied on their feeding grounds should kill many of them.

We have had no opportunity of carrying on any experiments against the insect, but Messrs. Yeomans, Walworth, N. Y., have given us the results of their efforts to check its ravages. The fact that many cigar-case-bearers and bud moths were doing much damage on the same trees where the pistol-case-bearer was at

*Mr. L. O. Howard, U. S. Entomologist, writes me that this Chalcid is a species of *Pteromalus*, probably undescribed. He also states that the pistol-case-bearer has a secondary parasite; it is Riley's *Cirrospilus flavicinctus*, described in Dr. Lintner's First Report, p. 159, as a primary parasite of *Bucculatrix*.

work, rendered it difficult to make any definite estimates of the results of spraying for the latter insect. Where the pistol-case-bearer was most numerous, they sprayed some of the trees twice before the blossoms were fully open, with Bordeaux mixture and London purple. On May 1st, Mr. L. T. Yeomans wrote us: "We may be mistaken, but it seems to us that we have not so many cases on our trees, where we have sprayed the second time." Kerosene emulsion was also tried when the insects were feeding in the latter part of April. A barrel of the emulsion was sprayed upon five trees, but Mr. L. T. Yeomans reported on May 11th, that he was unable to preceive any difference in the effect on the worms between trees thus sprayed and those unsprayed.

These experiments and our study of the habits of this pistol-case-bearer lead us to believe that it can be kept in check by *thorough* work with a Paris green spray, using one pound to 105 or 200 gallons of water, or Bordeaux mixture. The experience of Messrs. Yeomans indicates that it will require two applications of the poison before the blossoms open to effectually check the pest where it is very numerous. It would be well to combine the poison with the fungicide, Bordeaux mixture, in one of these sprayings, perhaps the second one, as this is the time when the apple scab fungus should receive its first check. This period between the swelling of the buds and the opening of the flower is also just the time when the bud moth and the cigar-case-bearer (which often work with the pistol-case-bearer) should be treated to a poisonous dose. As all three of these insects do their most destructive work before the blossoms open, an especial effort should be made to spray more thoroughly than usual. Do not wait until after the blossoms have fallen before striking a blow at these pests; although many of the pistol-case-bearers could doubtless be poisoned by a thorough application of the Paris green made just after the petals fall, which is also the best time to spray for the codlin moth or apple worm.

Never spray a fruit tree when it is in blossom. Remember that your success in fighting the pistol-case-bearer, and any of the other insects just mentioned, will depend almost entirely on how thoroughly the spraying is done.

MARK VERNON SLINGERLAND.

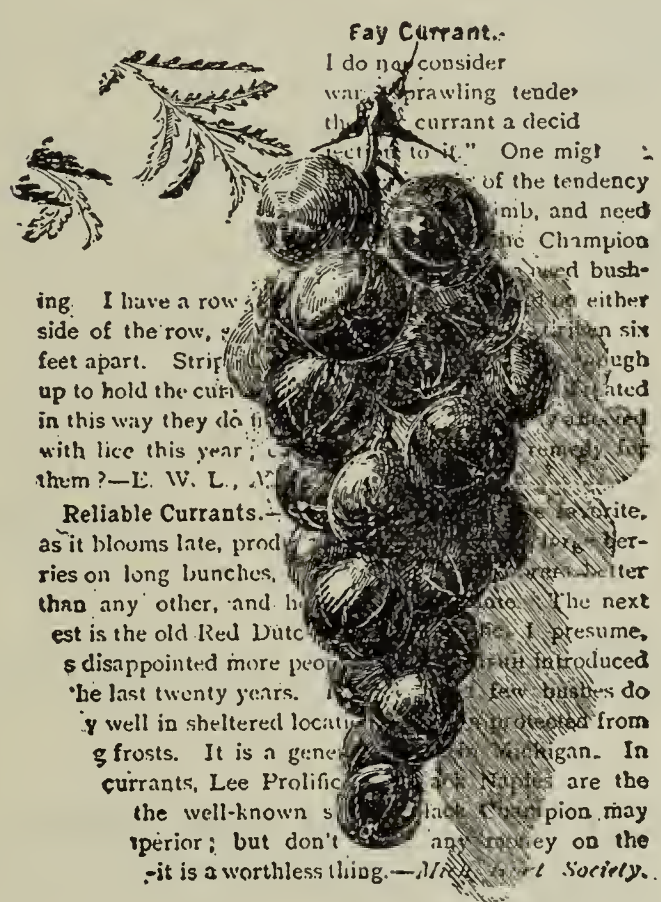
Bulletin 125. **February, 1897.**

Cornell University Agricultural Experiment Station,

ITHACA, N. Y.

BOTANICAL DIVISION.

A Disease of Currant Canes.



By E. J. DURAND.

PUBLISHED BY THE UNIVERSITY,
ITHACA, N. Y.
1897.

ORGANIZATION.

BOARD OF CONTROL:

THE TRUSTEES OF THE UNIVERSITY.

STATION COUNCIL.

President, JACOB GOULD SCHURMAN.

Hon. A. D. WHITE,	Trustee of the University.
Professor I. P. ROBERTS,	President State Agricultural Society.
Professor I. P. ROBERTS,	Agriculture.
Professor G. C. CALDWELL,	Chemistry.
Professor JAMES LAW,	Veterinary Science.
Professor J. H. COMSTOCK,	Entomology.
Professor L. H. BAILEY,	Horticulture.
Professor H. H. WING,	Dairy Husbandry.
Professor G. F. ATKINSON,	Botany.

OFFICERS OF THE STATION.

I. P. ROBERTS,	Director.
E. L. WILLIAMS,	Treasurer.
E. A. BUTLER,	Clerk.

ASSISTANTS.

M. V. SLINGERLAND,	Entomology.
G. W. CAVANAUGH,	Chemistry.
L. A. CLINTON.	Agriculture.
B. M. DUGGAR,	Cryptogamic Botany.

Office of the Director, 20 Morrill Hall.
The regular bulletins of the Station are sent free to all who request them.

BULLETINS OF 1897.

124. The Pistol-Case-Bearer in Western New York.
125. A Disease of Currant Canes.

Cornell University, Ithaca, N. Y., Feb. 1, 1897.

The Honorable Commissioner of Agriculture, Albany.

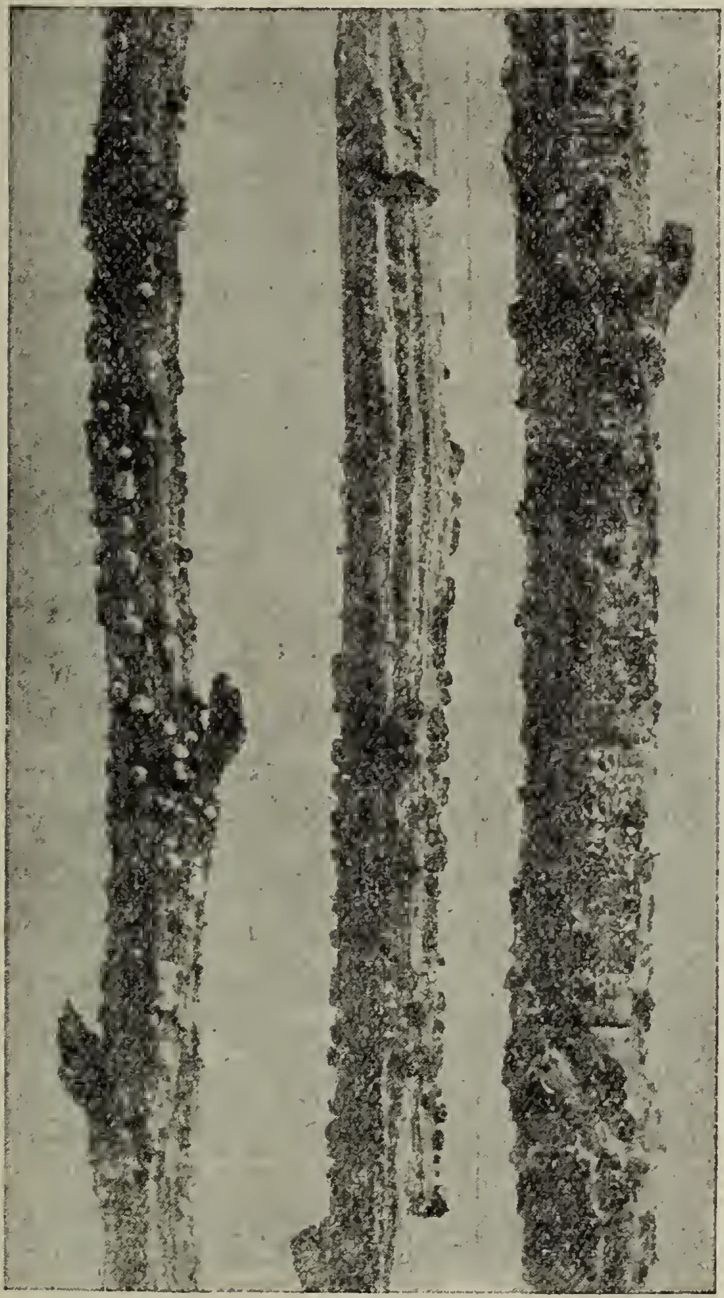
Sir: The following account of a currant disease, of which almost nothing has heretofore been known, is submitted as a bulletin under provision of Chapter 437 of the laws of 1896. This cane-blight is probably more widespread and serious than anyone has suspected, and it would not surprise us if it should be found that much of the trouble with currants which is laid to hard winters and poor soil is really the result of the work of this fungus.

L. H. Bailey.

2. *Diseased currant plant, showing dead canes and shriveled fruit.*

A DISEASE OF CURRANT CANES.

I. GENERAL CHARACTER OF THE DISEASE.



a. b. c.

3. *Diseased currant canes, natural size* (a, *Tubercles of Tubercularia;* b, *clusters of perithecia of Nectria;* c, *clusters of perithecia of Pleonectria*).

During the last few years there has existed, in various portions of New York state, a disease of currant bushes, which has been more or less destructive to the currant industry. The trouble was first called to the attention of the Experiment Station staff in June, 1895, when a diseased bush was received at the Botanical Department from Portland, Chautauqua county. Outside of this locality its effects have since been observed by the present writer at Canandaigua, Ontario county, and in the gardens of the Horticultural Department of Cornell University, in Tompkins county. It has also been noticed by Professor G. F. Atkinson in St. Lawrence county. Outside of New York state it has been reported from New Jersey by Dr. B. D. Halsted.

Inasmuch as the disease seemed to be a destructive one its study was thought to be of interest and importance. It was de-

termined, therefore, that the writer should visit the locality of the trouble in Chautauqua county to observe its effects upon the currant bushes, and to obtain material for study. Accordingly, on the 26th of June, 1895, the fruit-farm of Mr. I. A. Wilcox was visited, and notes taken upon the disease as it appears in the field.

Effects of the Disease.

The currant plot was found to be about one acre in extent. It originally consisted of several acres, but the death of the plants reduced it to the present size. About two-thirds of the bushes in the area at the time of the visit were either dead or manifestly diseased. The plants which had died the previous year were replaced in the spring of 1895 by new plants, which at this time were apparently unaffected.

The first effects of acute disease in the plant are seen in the wilting of the foliage, and the premature coloration of the fruits. The leaves turn yellow, dry up and fall away. The fruit clusters on affected plants are usually much smaller and more thinly fruited than on healthy ones, while the berries are colored prematurely, shrivel and fall away with the leaves, so that the canes are barren (Fig. 2.) The latter then die rapidly and soon dry up. Frequently the central canes of the bush die in the manner described, while the outer ones still retain their leaves. In nearly all such instances, however, the leaves of the living parts show indications of disease. Sometimes the plants die before the leaves unfold, so that the unopened flower and leaf buds may be seen upon the dead branches. In the worst cases, where all the canes are dead, the roots also die. Occasional instances were noted where fresh sprouts had been sent up around the base of the diseased canes.

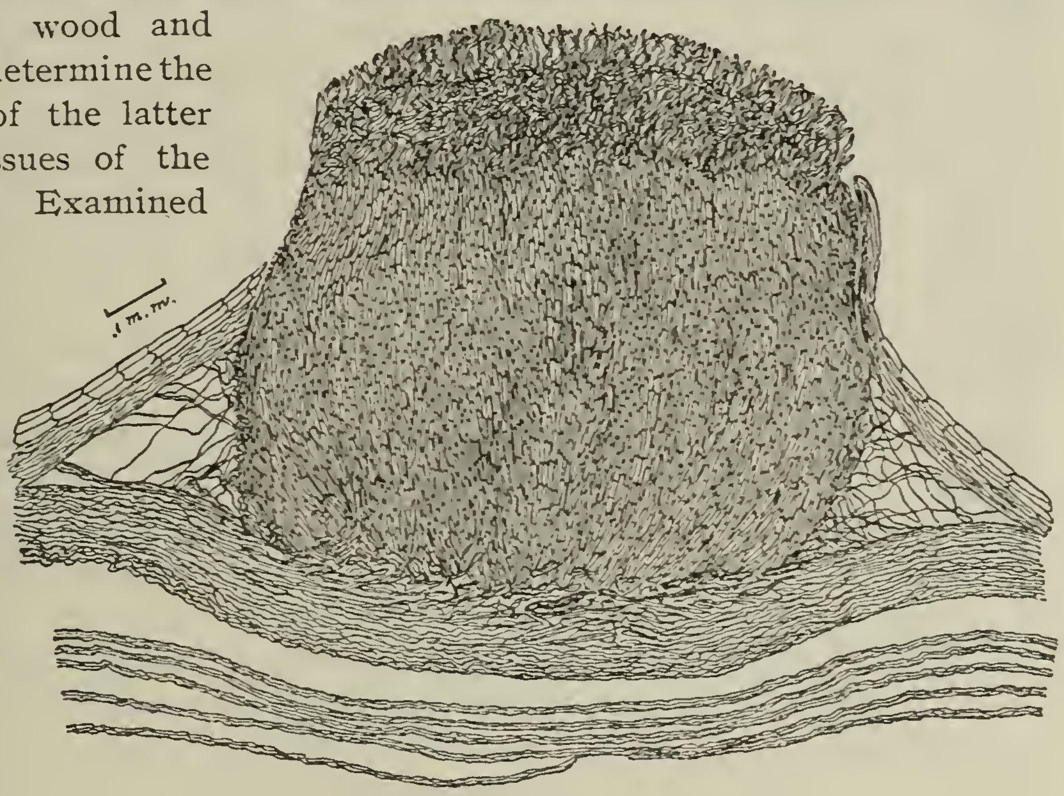
Cuttings made from apparently healthy bushes in this plot were unusually slow in growth, many of them not starting at all. Those which did start were very backward and amounted to but little. Two-year-old plants were also backward and slow in growth. The action of the cuttings suggests that the mycelium of the disease may be perennial in the tissues of the host plant, or, at least, that the vitality of the branch may be impaired before the effects of the disease begin to be noticeable.

II. THE BOTANICAL CHARACTER OF THE DISEASE.

The Fungus.

On a great majority of the dead canes the pink tubercles of a fungus of the genus *Tubercularia* were present (Fig. 3, *a*). They occurred most abundantly near the base of the stalk, but occasionally were found high up on the stem. Very few bushes were seen which had no tubercles on any of the canes. Sometimes they were present on much diseased stems not completely dead. In no case were they present on healthy plants. The tubercles were sufficiently abundant and so distributed on the diseased and dead stems as to render it probable that the fungus produced the disease and caused the death of the plants. A careful search was made for perithecial forms, but they were found on only a single plant. These with several specimens of the *Tubercularia* were collected for study.

An examination showed the tubercles to be the fruiting bodies of a well known species, *Tubercularia vulgaris*, Tode. Careful sections were made through the wood and tubercles to determine the connection of the latter with the tissues of the host (Fig. 4). Examined under the microscope, one of these sections shows that the vegetative part of the fungus consists of a delicate thread-like mycelium spreading abundantly through the tissues of the currant stem. The depredations are confined to the younger tissues of the host, within which it forms a wide weft between the cells. It thrives well in the inner bark or cambium layer, thus cutting off the nutriment and causing the death of the plant. The cells affected by the mycelium are much disintegrated and turn brown.



4. *Longitudinal section of a tubercle of Tubercu ria.*

The hidden mass of mycelium coursing through the tissues is the part that is destructive to the currant plant, since this is the only portion of the fungus that absorbs nutriment. The pink tubercles are the fruiting organs of the fungus. In their formation numerous threads of the mycelium turn outward from the bark as a bundle of closely compacted parallel filaments. As

growth progresses outward the mass brakes through the epidermis of the host, and appears as a pink cushion on the surface of the stem. A longitudinal section through one of these when examined under the microscope presents the appearance represented in the figure. The long, spreading mycelial threads may be seen coursing through the layers of the bark forcing the cells apart. In the tubercle itself the threads are broader and much septate by cross partitions, so that the mass thus formed resembles a tissue composed of narrow elongated cells. Toward the top of the tubercle the filaments are more compacted and thread-like. At the surface they become separated from one another and sparingly branched, each bearing small spores or conidia at its apex, and on very short branches or stigmata along its sides (Fig. 5). These conidia are exceedingly small measuring only 6–8μ long by 3μ wide. They are narrowly elliptical in outline and colorless. Immense numbers of conidia are borne on each tubercle, and, being so small and easily detatched, are scattered widely by the wind, thus forming a very efficient means of spreading the disease. Each conidium is capable of germinating under favorable conditions of temperature and moisture. The slender tube thus produced enters the tissues of the host, where it elongates and branches producing an abundant mycelium.

5. *Hyphæ of Tubercularia bearing conidia.*

The perithecia found on one of the canes were not fully mature, but were sufficiently so to admit of the determination of the species as *Pleonectria berolinensis*, Saccardo. This was afterward found to be a separate fungus in no way connected with the *Tubercularia*. All of the canes collected on the trip were planted in the leaves and humus in one of the nearby ravines, in the hope that more of the perithecial forms would be produced.

The History of the Fungus.

The *Tubercularia vulgaris* is a very common fungus which has long been known as a saprophyte growing on dead and decaying branches. Nearly all of the deciduous woody plants are numbered among its hosts, the genus *Ribes*, to which the currant belongs, being a favorite in this respect. It has passed under many names according as the forms on the various hosts were regarded as belonging to the same or distinct species. In 1865, Tulasne (Selecta Carp. Fungorum, III), united all these forms under the old name *Tubercularia vulgaris*, Tode, and gave numerous drawings and facts to prove its connection as an imperfect stage with the very common ascomycetous species, *Nectria cinnabarina*, (Tode) Fr. That this connection exists is evident, so that the fact has since stood unquestioned. In regard to the

special relation existing between these fungi and the currant, Dr. M. C. Cooke wrote for the Gardiner's Chronicle of Feb. 28, 1871, a short paper entitled "A Currant Twig and Something on it." Here were described in a popular way the pink cushions of *Tubercularia*, the mycelium, and the connection of this form with the globular, compound heads of the perfect stage *Nectria cinnabarina*. The plant described in this paper was found on a dead currant branch pulled out of a brush pile.

Its Occurrence as a Parasite.

Most of the writers treating of *Nectria cinnabarina* have spoken of it in a general way, as a saprophyte growing on dead or decaying woody plants. It has long been known, however, that both the *Tubercularia* and *Nectria* may thrive upon living plants in a truly parasitic manner. In Germany this condition seems to be not uncommon. As early as 1880, Dr. H. Mayr[1] studied the fungus as it occurred on living horsechestnut, maple (*Acer platanoides*), and linden, besides noting it upon elm, *Spiræa* and *Prunus*. In the case of the maple the spores germinated upon the cut end of a branch of a young tree, sometime during the year 1880. The mycelium spread to the main stem killing a portion of it. Here the first tubercles appeared, probably in the fall of the same year. During 1881, the new wood was seized upon and killed, so that in the autumn of the same year the leaves withered and died. At this time perithecia appeared on the tubercles of the previous fall. The same writer also studied the development of the fungus, describing and figuring the germination of the spores, and the conidial and perithecial forms. In 1893 and 1894, Wehmer studied some peculiar developments of *Nectria cinnabarina* on linden,[2] *Carpinus*,[3] and *Juglans regia*.[3] J. Behrens,[4] also, found the fungus parasitic on *Abies balsamea*. In the summer of 1896, Mr. B. M. Duggar, of the staff of this Station found the same fungus growing in a truly parasitic manner on a pear tree at Fayetteville, Onondaga County, N. Y.

The first mention of *Nectria* as a parasite of currants seems to be that of Dr. Halsted, who speaks of it as follows :[5] "In the currant regions of the state, particularly around Hilton and Irvington, there has been complaint of a blight affecting the canes of the currant. . . . . . . An affected plant may often be detected by the wilted foliage and premature coloration of the fruit. In some instances only a single cane in the bush may be attacked, while in the worst specimens the whole shrub is dead, except the fresh sprouts which may have arisen from the base of the plant. In early

[1] Ueber den Parasitismus von *Nectria cinnabarina*. Unters. a. d. forst-botanischen Institut zu München 3 : 1–16, 1883.

[2] Zum Parasitismus von *Nectria cinnabarina*. Zeitschrift f. Pflanzenkrankheiten. **1894** : 74.

[3] Einige weitere Beiträge zum Parasitismus von *Nect. cinnabarina*. Id. **1895** : 268–276 Pl. V.

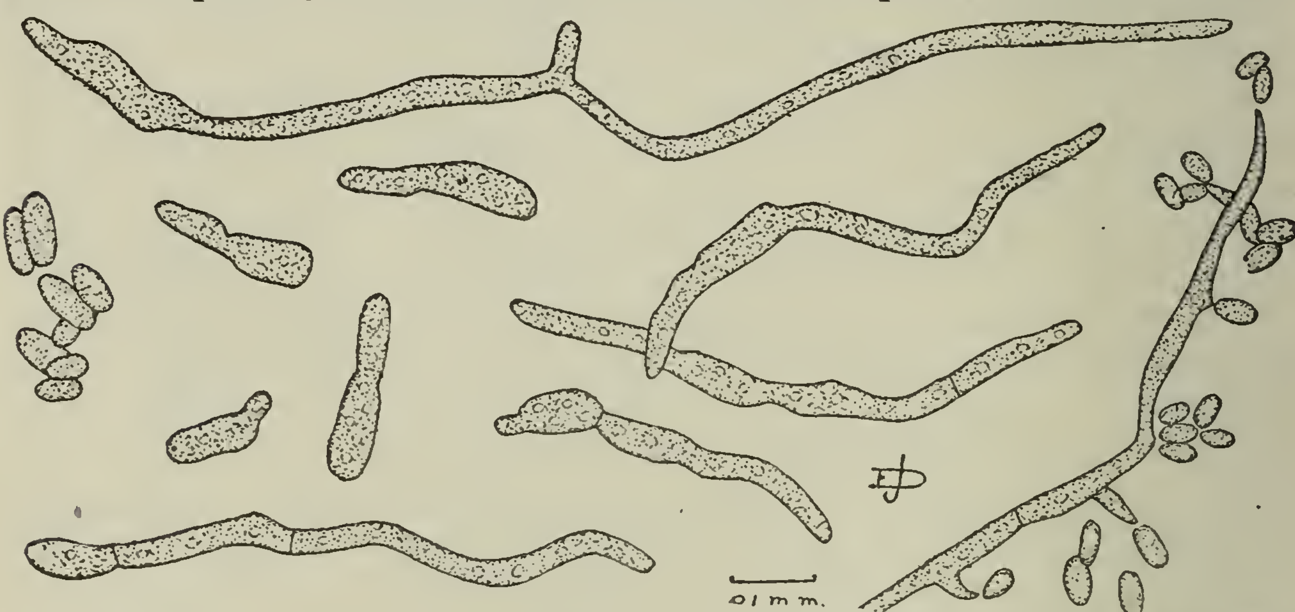
[4] Ein bemerk. Vorkommen v. *Nectria cinnabarina*, und verbreit weiss. d. Pilze. Id **1895** : 193–198.

[5] New Jersey Ag. Exp. Station, Report for **1894**, : 327.

July the blighted twigs often have their bark ruptured, and through the rifts there is to be seen a somewhat brick-colored fungus growth. Upon examination with the compound microscope, this red development is found to be the spore-bearing organs of a highly organized fungus belonging to the genus *Nectria*. This genus is not an unusual one among the fungi that are harmful to higher plants. . . The one upon the currant, when it seems to be deeply seated and does much damage, is nearly related to the *Nectria cinnabaria*, Tode, which is common on various trees." The effects of the disease in New Jersey are thus seen to be nearly identical with those observed in Chautauqua County.

Cultivation of the Tubercularia.

On November 16th, 1896, another package of diseased currants was received from Mr. Wilcox. The canes were badly affected, being thickly studded, especially about the lower ends, with the pink cushions of *Tubercularia*.



5. *Germinating conidia of Tubercularia. Portion of mycelium producing secondary conidia.*

The stems were covered and allowed to stand for a day in a moist place, so that the cushions were well moistened and swollen out. In order to avoid contamination as much as possible the spore-bearing tops of several of these cushions, after being shaved off with a sterilized scalpel, were crushed in boiled water on a flamed glass slip. Vast numbers of conidia were present. Dilution cultures of these were then made in acidified potato-agar in the usual manner. This was done in order that the germination of the conidia, and the development of the mycelium in artificial culture media might be studied. After twenty hours the spores had begun to germinate freely. The various stages of germination are illustrated in Figure 6. In this process the spore first swells to more than twice its original size through the absorption of moisture. A small protrusion then appears at one or each end of the conidium, which grows in length as a germ-tube. These tubes are quite large in proportion to the size of the spore, so that as growth pro-

gresses the original spore is soon lost sight of. In most cases the germ-tubes are soon cut off by septa. The protoplasm is at first nearly homogeneous, but soon becomes vacuolate in the older portions of the tube. After having elongated considerably the thread becomes sparingly septate by the formation of cross partitions. In old cultures the older parts of the mycelium are much sepate and filled with vacuoles. The threads soon begin to branch, until finally a spreading mass of densely interwoven mycelium is produced.

In threads thirty-six hours old, numerous small, short protrusions appear along the sides of the threads near the ends. These at first resemble incipient branches, but are usually of considerably less caliber than the main threads. They are as often curved as straight. When the bud is a little longer than the diameter of the main thread, a constriction appears near its base, so that the apical portion soon separates as a secondary conidium (Fig. 6). The base then grows out, so that other conidia are thrown off from the same point in a similar manner, until small clusters are present along the sides and apex of the main hypha. In old cultures these secondary conidia are present in immense numbers. As represented in the figures, the primary and secondary conidia are borne in precisely the same way along the sides and at the apices of hyphal threads. Being alike also, in size and shape, they differ only in that the primary conidia are produced on more or less erect hyphae, arising from the summits of the compact pink cushions formed by the coalesence of hyphal threads. The secondary conidia, on the other hand, are borne on separate hyphae, arising directly from the spores, and thus not forming a compact stroma. Morphologically, however, the two fruit forms are exactly alike.

Many cultures of the conidia of *Tubercularia* have been made, in all of which the mode of germination and production of secondary conidia were as described in the preceding paragraphs. Many of the cultures made from fresh material were more or less contaminated by the presence of bacteria or other fungi. In one set, however, plates two and three were pure, being thickly beset with numerous colonies of the *Tubercularia* alone. From plate three of this series transfers were made with a flamed needle to tubes of sterilized bean stems and potato-agar. At this time the colonies were about four days old, and secondary conidia were present in great numbers. Pieces of agar containing colonies were also transferred to sterilized currant stems in an Ehrlenmeyer flask.

On the potato-agar growth was rapid and profuse. The surface of the medium was soon covered with a felty growth, many of the hyaline threads extending far down into the mass. On the bean stems, also, the growth was rapid. The surface of the liquid was covered with a hyaline, felty growth, from which many of the threads projected downward as in the agar. The growth on the stems was sparse consisting of a thin weft of hyphae covering the substratum, and forming white flocculent tufts at the ends of the stems. After eleven days growth numerous small, hemispherical heaps or cushions began to appear on the bean stems at various points. These, at first, were

simply little tufts of threads about the size of a pin-head, but later they increased to several times that size. They were then pure white, somewhat compacted, and cottony in appearance. When examined under the microscope, these cushions were found to consist of erect parallel hyphae, much like fertile threads, but no conidia have yet been detected upon them.

On the currant stems in the Ehrlenmyer flask growth was at first slow. In a few days, however, a long sparse growth of mycelium could be seen spreading thinly over the surface of the stems. In a short time the mycelium became somewhat flocculent in spots, especially at the cut places where branches had been removed from the stems. After fourteen days growth, the white cushions began to be formed, especially at the cut surfaces mentioned. In appearance these were exactly like the ones described on the bean stems. When old they became yellowish, and closely compacted into a stroma, which was slightly pinkish within. Several instances have been noted in which a swelling or protrusion appeared at the summit or side of one of the white cushions, and which seemed at first to present every indication of a forming perithecium. It was soon found, however, that the protrusion was simply a true, pink stroma of *Tubercularia*, resembling in nearly every respect those found in nature. Conidia were present in great numbers at the summit of the mass. In the flask, also, on the felty mass covering the surface of the currant leaves and liquid at the bottom, small pink tubercles have arisen, which in many respects resemble those found on the currant stems in nature.

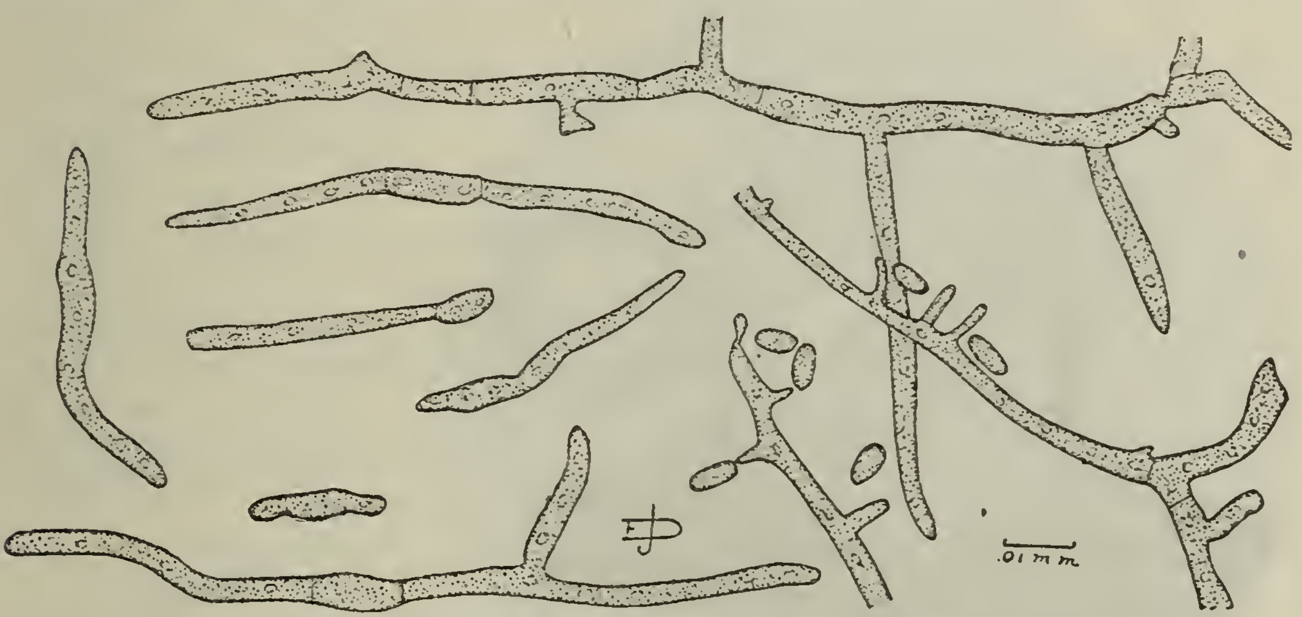
It may be mentioned at this point, that in none of the artificial cultures has there appeared any indication of the fruit-bodies described by Mayr[6] as macroconidia. These were said to be long, fusoid, several-septate bodies, borne on tufts of white mycelium, at points where the stromata of *Tubercularia* later appeared. The macroconidia after germination produced secondary macroconidia of a similar form, by budding-off from the mycelium. It was thought at first, that the white cushions mentioned in the last paragraph might represent these macroconidial stromata, but a careful search has failed to reveal any fruiting-bodies of such a form. The fact that no such bodies appeared in the carefully made pure cultures, together with their very marked similarity to the conidia of a very common saprophytic fungus of the genus *Fusarium* has raised the suspicion that perhaps the macroconidia may have belonged to another fungus not connected with *Tubercularia*.

In order to determine the function of the secondary conidia thrown off from the mycelium growing in agar, dilution cultures were made, that they might be obtained in pure cultures. This was done by transferring a portion of a *Tubercularia* colony, containing numerous secondary conidia, to three agar tubes successively and pouring into plates in the ordinary manner. Plate number one was then examined under the microscope, and the position of the conidia marked on the glass. After twenty-two hours these

---

[6]Untersuch. a. d. forst-botan. Inst. zu München. 3 : 1-16, Pl. I, figs. 18-21.

marked spores were found to have germinated in a manner similar to that described for the primary conidia taken from the pink tubercles. The spores first swelled to several times their former size, when germ-tubes were pushed out from the sides and ends (Fig. 7). The protoplasm was granular and filled with vacuoles. Septa appeared early, cutting off the tubes at their points of origin. After forty-eight hours growth, the mycelium was found to be much branched, quite dense, and not widely spreading. The main hyphae had put out short branches quite simultaneously along their sides, so that the lateral branches were of nearly equal length. After fifty-six hours these branches were throwing off secondary conidia precisely as tbe mycelium from the primary conidia had done (Figs. 6 and 7). It will be seen, therefore, that the primary and secondary conidia behave almost exactly



7. *Germinating secondary conidia of Tubercularia.*

alike in their germination, and in their production of fruiting bodies. This is no more than might be expected when we remember that the two forms are morphologically similar.

The behavior of these colonies varied much with the food supply. In plate number one, after the nutriment had become nearly exhausted on account of the large number of colonies present, the mycelial threads became very profusely and compactly branched, forming close colonies. The protoplasm became full of very large vacuoles. In plates number two and three, where the nutriment was more abundant, the threads were much longer, more slender, and less branched, thus forming a more spreading colony. The protoplasm was nearly homogeneous with few vacuoles.

On March 14, 1896, colonies produced from secondary conidia were innoculated on sterilized currant stems, neutral bean stems and acid bean stems. Here again the growth was similar to that described for the primary conidia. The mycelium grew slowly, but after three days, formed a thin weft over the stems. After four or five days the small white cushions began to form and increase in size, in nearly every respect resembling those previously described.

The various cultures and innoculations detailed in the preceding paragraphs were made in the hope that it would be possible, finally, to trace in artificial cultures the exact relation and connection existing between the *Tubercularia*, and the perithecial forms of *Nectria* and *Pleonectria*. It may be said, however, that at the time of the present writing, after a lapse in some cases of many months, nothing but the stromata of *Tubercularia* has appeared in the cultures. In explanation one might cite Mayr's observations on the maple (see p. 27). In this case the perithecia did not appear until a full year after the stromata had been formed. It is known, too, that many forms require a much longer time than this to attain to their complete development under artificial conditions. The methods of culture may not have been favorable to the production of the perfect form. It is known that many species require a period of rest before such forms will be developed. That a connection exists between *Tubercularia vulgaris* and *Nectria cinnabarina* has been abundantly demonstrated, so that the fact is no longer open to question (Mayr, l. c.)

9. *Longitudinal section of a stroma and single perthecium of Nectria.*

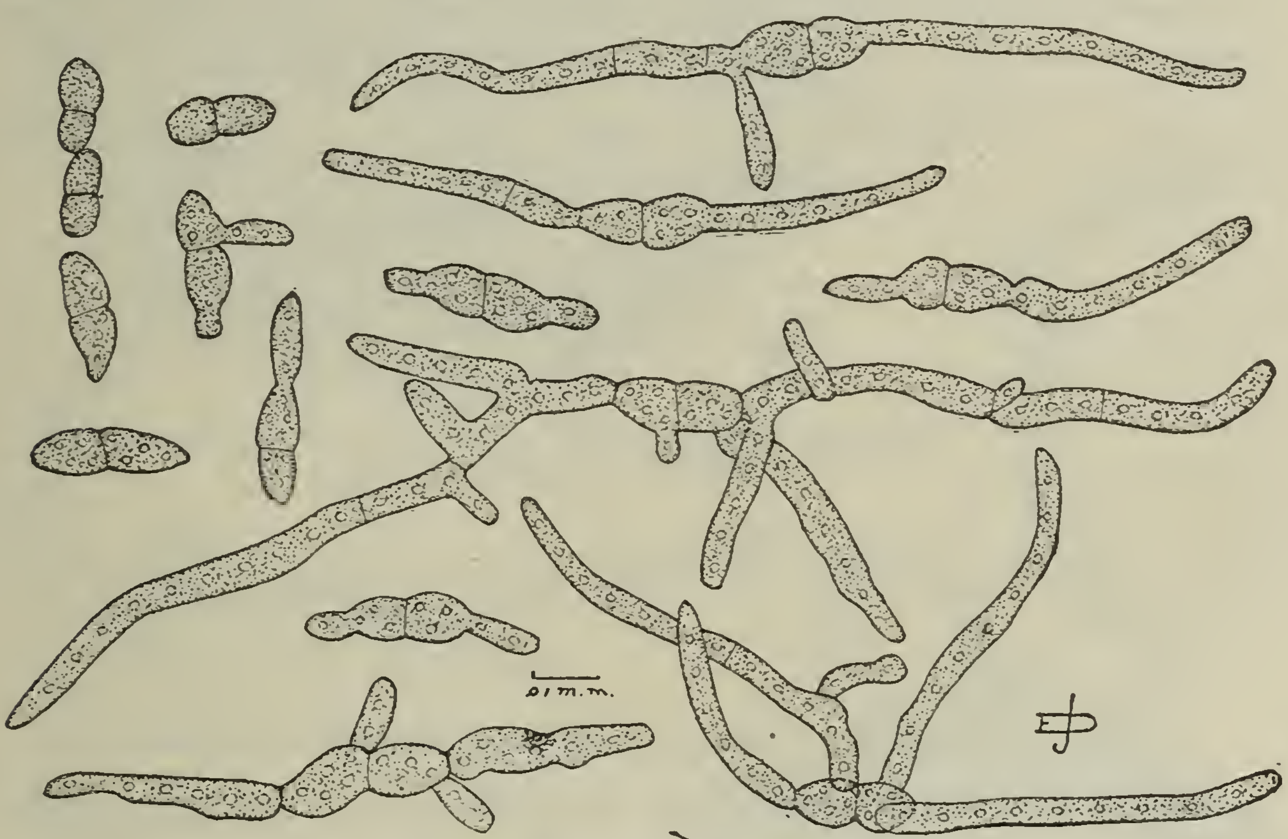
Nectria cinnabarina.

All of the perithecia developed during the fall of 1895, on the currant bushes planted in Fall Creek Ravine, were those of *Pleonectria*, which is not connected with *Tubercularia* as is shown in a succeeding paragraph.

The canes were examined at intervals during the fall and winter of 1895–96, but it was not until February that a branch was noted, on which clusters were present, which differed decidedly in appearance from those previously observed on this material (Fig. 3, *b*.) The perithecia were a light brick-red in color, were small, spherical, and densely crowded, and covered with little granules, giving them a rough appearance. There was no depression at the apex as in *Pleonectria*. The clusters were seated on prominent stromata, evidently those of *Tubercularia* (Fig. 3, *b* and 9.) The tubercles and perithecial clusters were intermingled freely. Many tubercles

were present, from the bases and sides of which the perithecia were projecting. All gradations could be seen, from the simple tubercles covered with conidia, through those bearing one or several perithecia, to those entirely covered by clusters. Conidia were present on all of these stromata.

A microscopical examination showed, as was suspected, that the fungus in question was none other than *Nectria cinnabarina* (Tode) Fr. If a perithecium be split longitudinally an appearance represented in Figure 9 is produced. It consists of an outer shell composed of coalesced threads. Springing from the bottom of this are numerous club-shaped sacks or *asci* which converge toward the apex of the perithecium. Each ascus contains eight elliptical spores which are divided into two cells by a cross-wall near the middle. They measure $12–15 \times 5–7\ \mu$.



10. *Germinating spores of Nectria.*

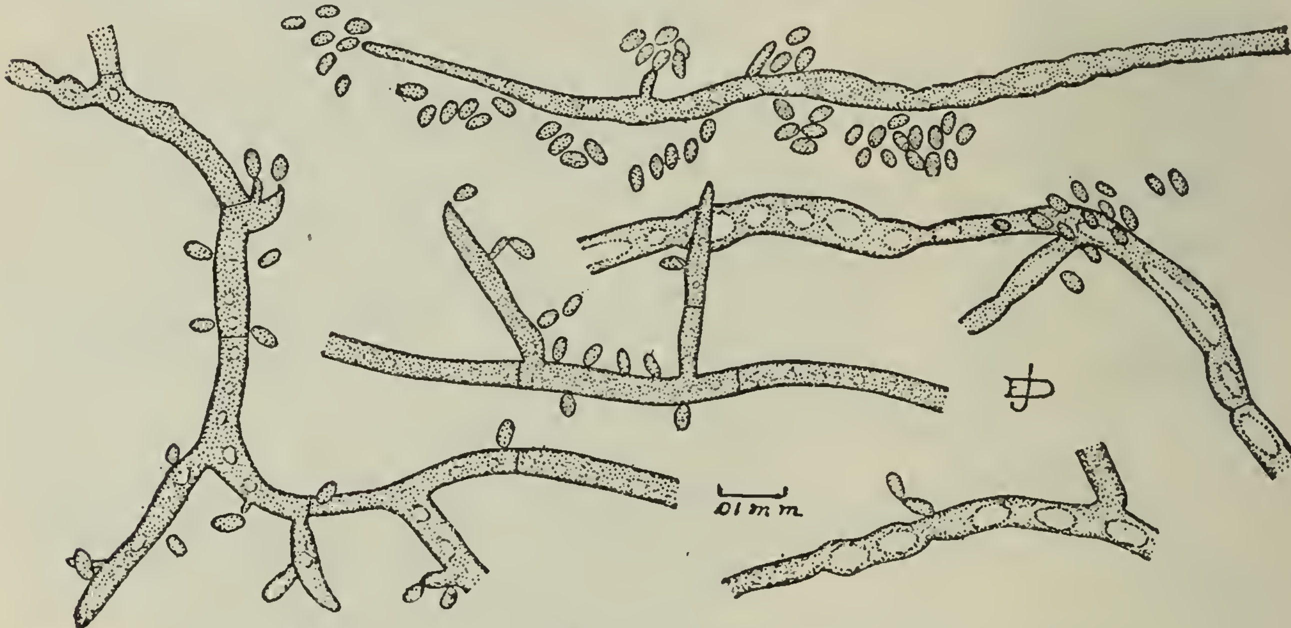
Cultures of the mature spores were made in acidified potato agar. The upper part of a cluster of perithecia was cut off with a flamed knife, the contents crushed out in boiled water, and dilutions made in the ordinary way. The plates were kept at the room temperature, 70 to 80 °F. The spores swelled and germinated after twenty-two hours. In nearly every instance both cells of the spore germinated, each sending out one or two germ-tubes (Fig. 10). The tube more often originates at the end of the spore than at the side. There is often a more or less prominent constriction of the germ-tube at the point where it leaves the spore.

At this time no septa were present, the protoplasm of the tube being continuous with that of the spore, and faintly vacuolate. After twenty-eight hours branching had begun and a few septa formed. From this time growth advanced rapidly until the threads had branched into a spreading myce-

lium. After three days, the protaplasm became full of vacuoles placed at regular intervals. At this time conidia began to be thrown off from short lateral branches in a manner similar to that previously described. They were 4—5 μ long, or about the size of those of *Tubercularia* (Fig. 11).

When the cultures were four days old small portions of the agar containing colonies were transferred to sterilized currant and bean stems. The mycelium spread from the point of innoculation until a sparse cottony growth appeared over the stems, especially at the cut ends. Development was more vigorous on the currant than on the bean stems. After nine days growth minute white cushions began to be formed on the surface of the stems. These increased in size, and resembled in every way those previously described for *Tubercularia*. No perithecia have yet been produced in artificial cultures.

Cultures were also made of the conidia produced on stromata from which perithecia were borne. The germination, mycelial growth, and white cush-



11. *Mycelium of Nectria producing secondary conidia.*

ions produced resembled exactly the like phenomena in the case of *Tubercularia*.

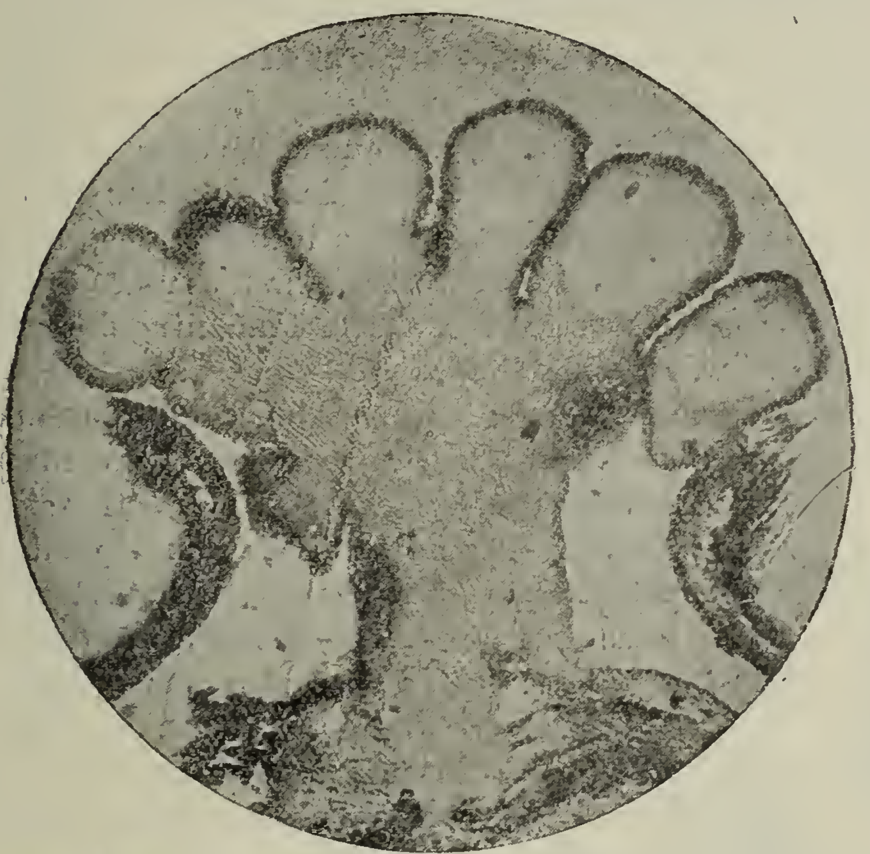
Pleonectria berolinensis.

Reference has already been made on a previous page to the perithecia of *Pleonectria berolinensis*, Sacc. found on one of the currant canes brought from Chautauqua county. This species has long been known as an inhabitant of dead currant stems both in Europe and America. In North America it is said to occur on dead stems of *Ribes*, in Canada and the Northern United States, west to Montana.

No reference to this fungus as a parasite has been found. At the time the specimen was collected it was thought that perhaps the species might be another perfect form connected with the *Tubercularia*. The evidence, however, is against this view.

The currant bushes which had been placed in the ravine, as described on page 26, were left undisturbed during the summer and fall of 1895. About September first, perithecia began to appear abundantly near the bases of the

stems. By October first, many of the branches had produced large numbers of the fruit-bodies with mature spores (Fig. 3, *c.*). These resembled in nearly every detail the specimens of *Pleonectria berolinensis*, Sacc. in Ellis and Everhart's North American Fungi, No. 470.



13. *Longitudinal section of a cluster of perithecia of Pleonectria.*

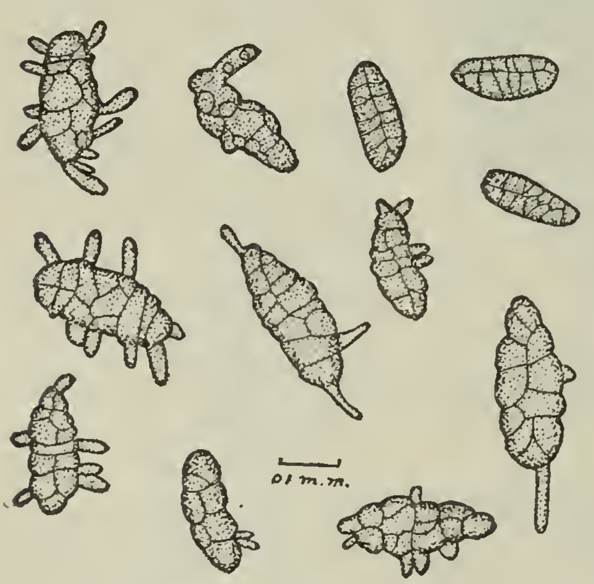
The perithecia are minute, smooth, spherical or pear-shaped bodies, and are usually borne in clusters closely crowded together. The color is brick-red or reddish-brown, bright when the plants are fresh, but duller when dry. Each cluster is usually seated upon a more or less distinct stroma, but seldom, if ever, is this a cushion of *Tubercularia*. Most of the specimens examined seem to be nearly sessile upon the wood, but an evident stroma is shown in Fig. 13. The clusters originate beneath the bark, but as they grow older and larger, they break through and appear on the surface, bordered by the ruptured edge of the epidermis. Occasionally, several clusters are joined side by side, forming a ring extending nearly around the stem. In some instances, when the bark had been torn away, the perithecia are not clustered, but entirely distinct and superficial on the wood. In such cases there is no evidence of an underlying stroma, certainly none of *Tubercularia*. When fresh the perithecia are swollen out and nearly spherical; but when old and dry the apical

14. *Longitudinal section of a single perithecium of Pleonectria.*

portion around the minute opening collapses, so that a distinct and characteristic saucer-shaped depression is produced in each.

When the interior of the perithecium is examined a condition represented in Figure 14 is found. Around the outside is a wall or shell of sterile tissue, formed by the coalescence of hyphal threads. Projecting from the bottom of this wall, and converging toward the apex, are numerous cylindrical or club-shaped sacks, the *asci*, each containing eight elliptical, colorless spores. Each spore is divided by from five to seven cross-walls into sections, many of which are further divided by walls running across the first, as represented in Figure 15. The spores measure 16–22x7–8 μ. The remaining interior part of the perithecium is filled with sterile tissue.

The spores are capable of germinating under favorable conditions and reproducing the species. Numerous cultures of the ascospores were made during the fall of 1895. Growth takes place freely in both acid and neutral potato-agar. A typical culture was started December 6th. At three in the afternoon, a dilution of three plates was made in acidified potato-agar, and kept in a room where the temperature was 70–80° F. On Dec. 7th, after twenty-one hours, germination had begun.



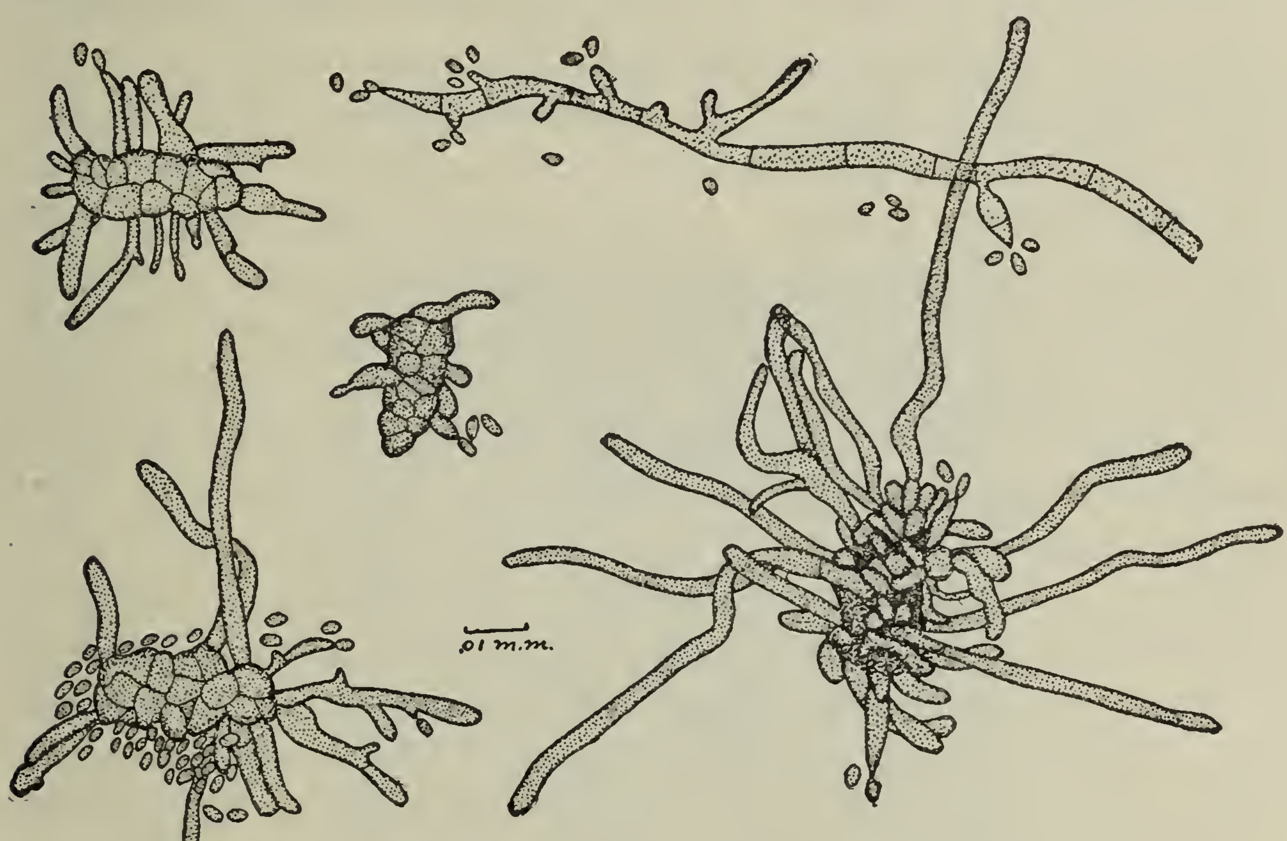
15. *Germinating spores of Pleonectria.*

The spore first swells to several times its former size through the absorption of moisture. Small protrusions then appear at various points, which elongate more or less as germ-tubes (Fig. 15). In many cases the threads, after elongating a little, begin to throw off conidia by constriction from their apices (Fig. 16). Such threads grow no further, but continue to cast off conidia in numbers. The conidia are oval in form, 4–6 μ long, and closely resemble those of *Tubercularia*, except that they are a little smaller. The other germ-tubes elongate much by apical growth, and become much branched, forming a compact mycelium. Branching begins quite early, but septa do not become numerous until the thread has attained a considerable length. No definite relation could be seen between the number of germ-tubes and the number of cells of the spore. It occasionally happened that two or three tubes came from one cell, while some cells put out none.

After the mycelium was three days old, conidia in great numbers were cast off from the sides of the threads, much as in the case of the *Tubercularia* (Fig. 16). Short lateral branches are put out, which become constricted when as long as the diameter of the thread, and the apical portion is thrown off as an elliptical conidium. This process may be continued indefinitely by the same brauch. The form of the lateral branches varies, some being long and tapering, while others are short and conical.

Innoculations were made from the plate cultures to sterilized bean stems by

touching a flamed needle into a colony containing many conidia, and touching again to the stems. The only resulting growth, at first, was a thin, sparse mycelium, which was scarcely noticeable. No white cushions were produced. After about two weeks growth, in two of the cultures, minute red points appeared. When these had increased to the size of a pin-head minute red protrusions were pushed out from the summits of several of them. When examined under the microscope, each red point was found to be a stroma composed of compact hyphae, but bearing no conidia. The protrusions presented every appearance of being forming perithecia. Unfortunately, the cultures were spoiled at this time, so that the resulting growth could not be traced.



16. *Mycelium of Pleonectria producing secondary conidia.*

Mycelium of *Pleonectria* was also innoculated to bean stems on which cultures of *Tubercularia* were growing, but the growth seemed to be in no way modified thereby.

Innoculations.

On May 4th, 1896, a series of innoculations of *Nectria*, *Pleonectria* and *Tubercularia* was made on currant cuttings. These were kept for a time in a forcing room in the conservatories, but were soon placed out-of-doors, after several of the plants had been attacked and killed by another fungus (*Botrytis*). About June 25th, several small, pink *Tubercularia*-like bodies appeared on two of the dead stems. These bore no conidia. Nothing has yet been produced on the living plants, nor, in the light of Mayr's experiments noted on a previous page, could results be expected in so short a time.

On the fifth of June, fresh conidia from Chautauqua county were innoculated on living currant bushes in the Horticultural grounds. An incision was made through the bark into the wood of young shoots, and portions of tubercles bearing conidia inserted. No results have yet been obtained from this experiment.

III. REMEDIES.

We have seen that the mycelium of the fungus, after having once gained entrance to the plant, lives from year to year in the tissues of the host; that it may remain there a long time without producing any external indications of its presence; and that in this way it may be transmitted through cuttings. The first suggestion, therefore, is that all cuttings be taken from plants known to be free from the disease. It is not safe to take cuttings from apparently healthy plants in a diseased patch, but they should be obtained from localities where the disease is not present. This is the more important, since the conidia (or summer spores) exist in the soil and on the bushes, so that cuttings are liable to infection through their cut surfaces, as Mayr has pointed out. The trouble being a deeply seated one, and the conidia liable to dispersion at various seasons of the year, spraying is not to be recommended. The conidia probably do not affect entrance to the plant through healthy parts, but through cut or injured surfaces. These should, therefore, be avoided as much as possible. The only positive remedy that can be suggested is the removal of the whole plant as soon as the disease begins to be manifested in the yellow foliage and prematurely colored fruits. The diseased plants should be burned, as the spores and conidia may be produced in abundance on dead plants and the trouble communicated to living bushes.

E. J. DURAND.

Bulletin 126. **February, 1897.**

Cornell University Agricultural Experiment Station.

ITHACA, N. Y.

ENTOMOLOGICAL DIVISION.

The Currant-Stem Girdler

—AND—

The Raspberry-Cane Maggot.

By M. V. SLINGERLAND.

PUBLISHED BY THE UNIVERSITY,

ITHACA, N. Y.

1897.

ORGANIZATION.

BOARD OF CONTROL:

STATION COUNCIL.

BULLETINS OF 1897.

THE CURRANT-STEM GIRDLER.

Janus integer, Norton.*

Order HYMENOPTERA ; super-family TENTHREDINA.

The indications are that currant growers will soon have another serious enemy to combat. Most growers are already familiar with the operations of the "green worms," and many have had their bushes badly damaged by one or both of the two common currant borers, known as the imported borer and the American borer. Within the past few years, however, an insect which is both a girdler and a borer, has been attracting considerable attention by its destructive work in quite widely separated portions of the country. Unfortunately the ravages of the insect seem to be increasing each year, but fortunately a study of its habits has shown that it can be easily and quickly checked. Every currant

---

*SYNONOMY.

Cephus filicornus. Harris' MS. catalogue. A manuscript name given by Say for a male specimen taken at Milton, Mass., in September, 1830.

Cephus integer. Harris' MS. catalogue. A manuscript name given by Say for a female specimen taken on a window at Cambridge, Mass., June 20, 1832.

1861. *Cephus integer* Norton. Proc. Bost. Soc. Nat. Hist., VIII, 224. First description of the insect, from Harris' specimens.

1862. *Janus flaviventris* Fitch. Seventh Rept. on N. Y. Insects, p. 852. Description of adult.

The willow-shoot saw-fly discussed by Dr. Riley as *Phyllœcus integer* Norton is doubtless another insect, *Janus abbreviatus* Say, according to Mr. Harrington (Canadian Uroceridæ, in Trans. Roy. Soc. Canada for 1893, p. 133). Dr. Riley admits that there were some differences between his specimens and Norton's description of *J. integer*.

The reference of Fitch's *J. flaviventris* as a synonym of Norton's *J. integer* was made after a careful examination and comparison (by Mr. A. D. MacGillivray) of the former's description and our bred specimens with Norton's descriptions and the original type specimen from the Harris collection. According to Know's latest generic table, the insect belongs to the genus *Janus*.

grower should therefore at once familiarize himself with the workings of this new pest, and thus be prepared to check it whenever any indications of its presence appear on his bushes.

Through the kindness of Mr. B. M. Hoag, South Easton, N. Y., in furnishing us an abundance of material, we have been enabled to breed the insect in our cages here at the insectary during the past year. Several new facts have resulted from this study of the pest; for instance, we had the pleasure of being the first to see the insect perform the interesting operation of girdling a currant shoot. (See plate IV, figure *a*.)

HISTORICAL.

This new currant pest is an American insect. As early as 1830, Dr. Harris captured a male specimen at Milton, Mass., and in 1832 he took a female on a window at Cambridge, Mass. Both these specimens were given different manuscript names by Say, but they were not described. Nearly thirty years passed before the insect again received any attention. In 1861 Norton wrote a description of it, evidently from Harris' specimens; he used one of Say's names for it, and stated that it also occurred in New York state. In 1862, Dr. Fitch described the same insect under a new name; he had captured it in May in New York state, and thought it might possibly be the insect that was boring in the rye stems.

The insect does not seem to have been mentioned in print again for a quarter of a century, or until 1888. But some of Professor Comstock's old unpublished notes show that Mr. J. F. Rose, South Byron, N. Y., had observed the work of a "new borer" in his currants in 1882. In February and April, 1883, he sent specimens of the injured shoots to Professor Comstock who succeeded in breeding the adult insect, which he determined at the time as being doubtless the insect described by Dr. Fitch in 1862. Thus these observations were the first to throw any light upon the habits of the insect, but as they were never published, it was not until 1888 that anything was recorded about any insect girdling currant shoots; and it was not until 1891 that it was publicly

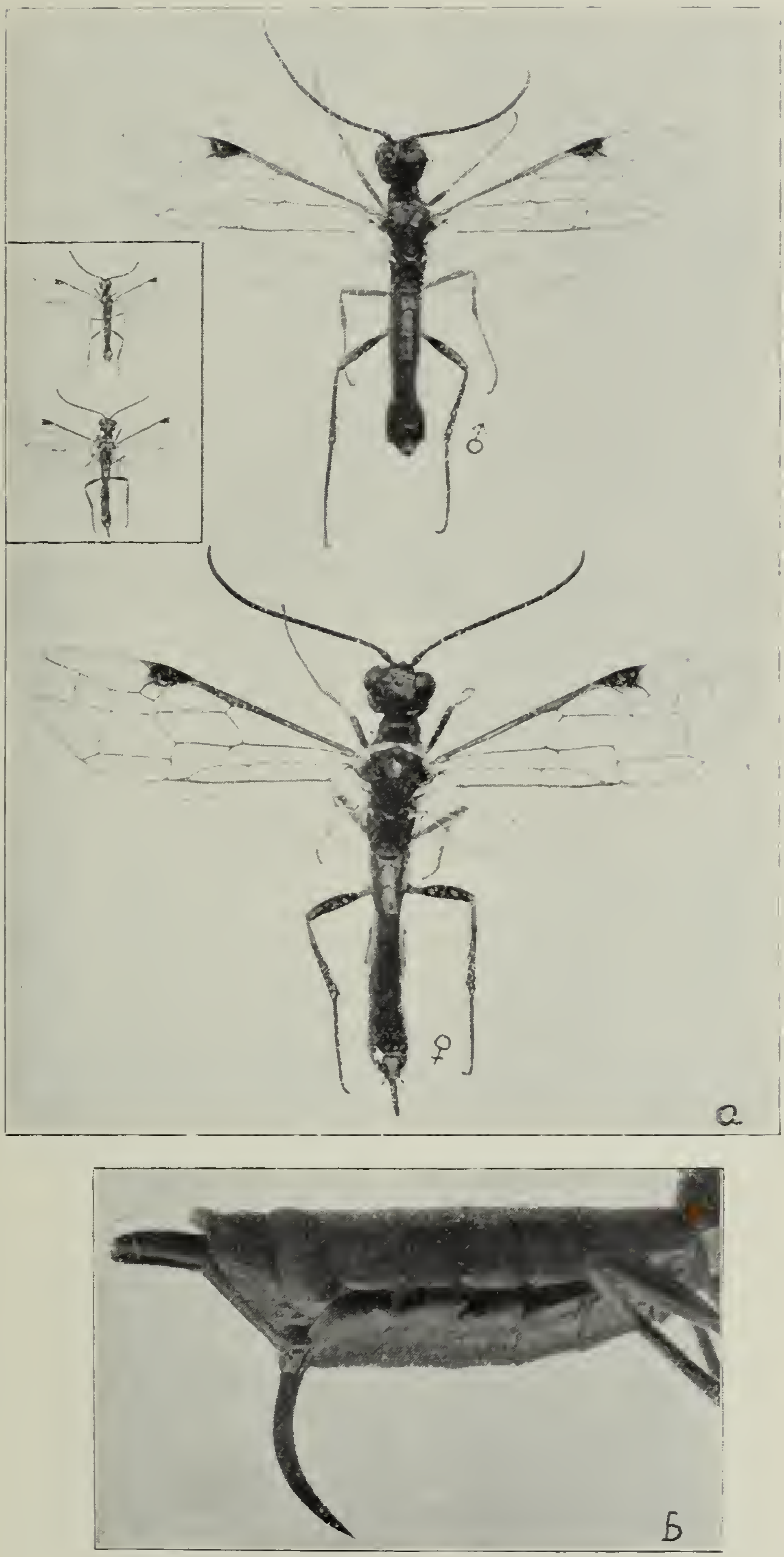


PLATE III.—a, *male and female of the currant-stem girdler* (*Janus integer* Norton), *much enlarged; the same are represented natural size on the left of this figure.* b, *abdomen of the female saw-fly with its saw-like ovipositor in position for ovipositing or girdling. Much enlarged.*

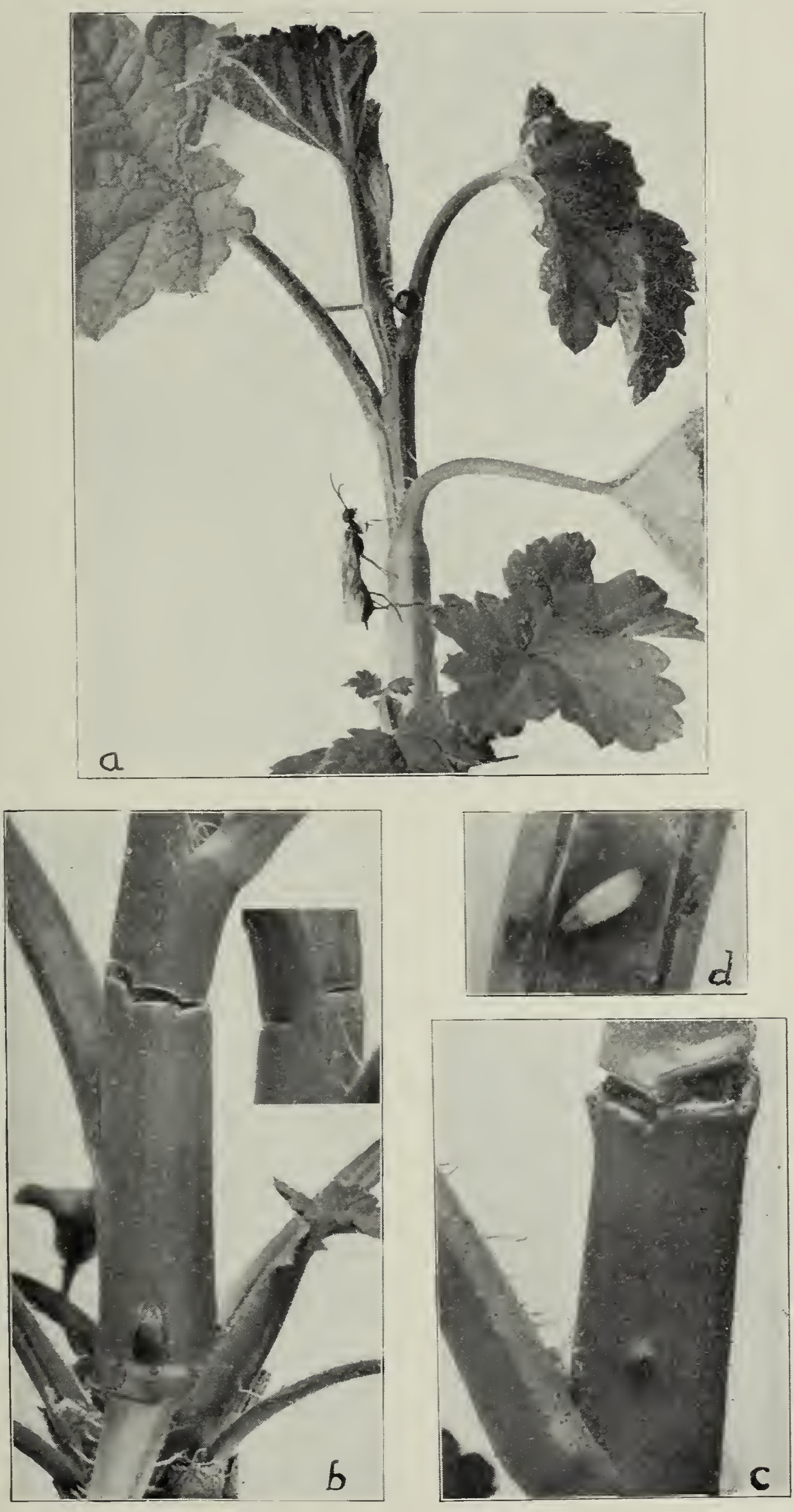


PLATE IV.—a, *the female at work girdling a currant stem, natural size;* b, *girdled portion of a stem, much enlarged, to show the character of the girdle;* c, *girdled portion of a stem a few days after the girdling was done, much enlarged, to show the egg-scar;* d, *currant stem cut open to show the egg of the insect, much enlarged.*

known that the author of this girdling was the insect described by Dr. Fitch in 1862.*

In 1886, the work of the insect was seen on currants at Adrian, Mich. In 1887, Dr. Lintner obtained specimens of injured tips from several gardens in the vicinity of Albany, N. Y., and some were sent to him from Macedon, Wayne Co., N. Y.; it was also known to occur in Canada as early as 1887. In 1891, girdled tips were found at South Byron and Chatham, N. Y. Professor Claypole recorded in 1892 that he had observed the work of the insect for several years at Akron, O. It attracted attention at Centreville, R. I., in 1892, and in 1894 the insect was quite numerous there, and also in different parts of Massachusetts. Our notes show that in 1895 considerable damage was done by the insect at South Easton, N. Y.; specimens were also sent to Dr. Lintner from Corning, N. Y.

ITS DISTRIBUTION AND DESTRUCTIVENESS.

The above historical notes show that this currant stem-girdler was first found in Massachusetts and has since been recorded in Rhode Island, New York, Canada, Ohio and Michigan. It is quite widely distributed over New York state.

As will be shown in our discussion of the life-history of the pest, it is capable of doing much damage to currant bushes. Thus far, however, its ravages have been confined to limited localities. We have no definite data in regard to the extent of its ravages. It has attacked the Cherry and Fay's Prolific currant, and the black currant. Doubtless the insect has no choice of varieties. It probably breeds freely on the wild currants from which it has recently turned its attention to the cultivated varieties.

INDICATIONS OF THE PRESENCE OF THE INSECT.

Observant currant growers will have no trouble in determining

*In 1887, many currant tips were girdled in the vicinity of Albany, N. Y., and in 1888, Dr. Lintner published an account of the work of this then unknown insect. In December, 1890, Mr. Allis, Adrian, Mich., wrote to Dr. Riley that he had bred in 1887 one pair of the insects which had been girdling his currant tips as described by Dr. Lintner; in 1889 he raised another adult which was sent to Dr. Riley to name. Dr. Riley replied that the insect was without doubt Fitch's *Janus flaviventris*.

whether this stem girdler is at work on their bushes or not. The results are very conspicuous from the first, as is well shown (half natural size) in the frontispiece. In May, after the new shoots have reached a growth of several inches, two or three inches of the tips of those attacked by the insect will suddenly wilt or fall over and hang suspended or may fall to the ground. A careful examination of the shoot at the point where it broke off will show that it was deftly girdled with several sharp, somewhat curved cuts extending nearly through the stem. Figures *a*, *b*, and *c*, plate IV. illustrate this girdling process which will be discussed in detail when we tell the life-story of the insect. Sometimes where the stem is quite large or the cuts do not extend deep enough, the tip will remain upright for several days or more, but it usually wilts, dies, and breaks off later. This girdling, of course, stops all further growth of the shoot at the tip, thus disfiguring and stunting that portion of the bush for the rest of the season. This severing of the terminal shoot, is, in fact, the principal damage done by the insect. Sometimes the growth of a very thrifty shoot will be continued by one of the side buds below the girdle, as shown (half natural size) on the right of figure 17.

17.—*Currant stems as they appear in winter, after having been girdled by the insect in May. One-half natural size.*

The injured shoots can also be quite readily discovered in the winter; the three shoots shown in the left of figure 17 were cut before growth began in the spring. They show that the girdling in the preceeding May had effectually stopped all growth during the season. The characteristic dead stubs on the ends of injured shoot render them sufficiently conspicuous to be recognized by

observant currant growers in the winter. Thus one phase of the work of this insect—its girdling habit—fortunately makes it a comparatively easy matter to ascertain whether it is present in a currant plantation or not, either during the growing season or in the winter.

THE INSECT'S APPEARANCE.

Although the insect makes its presence known in the conspicuous manner shown in the frontispiece, it is so shy that no one has ever caught the girdler at its destructive work on the bushes in the field. Thus currant growers will rarely, if ever, meet with the adult insect—the saw-fly—which does the girdling. However, many will be interested to know how the ingenious girdler looks. Both sexes are therefore shown, natural size, at the right of the much enlarged figures of the same at *a*, plate III. The insect is one of the saw-flies and is thus closely allied to the parents of the well-known "green-worms," which every currant grower has to fight almost annually. They are called saw-flies from the fact that they have a saw-like ovipositor; it is quite a formidable affair in the case of the currant stem-girdler, as figure *b*, plate III shows. The uses to which this insect puts this saw-like instrument are discussed further on.

As the figures show, the male insect is somewhat smaller than the female, and it also differs somewhat in its coloring; both are pretty little saw-flies with shining black bodies and light brownish-yellow legs. In the male, nearly all of the abdomen is of a brownish-yellow color, while in the female the first half of the abdomen is of a reddish-orange color and the rest is black. The mouth-parts, in both sexes, are of a light lemon-yellow color, and similarly colored markings occur on the thorax around the bases of the wings.* The adults fly in May, and perhaps some currant growers may be fortunate enough to see some of the shy little creatures. The other stages of the insect—its egg, the grub, and the pupa—are to be found only in the currant shoot below where it was girdled. To see them one must split open the injured shoots at certain times during the summer. These earlier stages of the

*For detailed specific descriptions of both sexes see Insect Life, VI, 300.

insect and the proper time to look for them are discussed under its life-history.

THE STORY OF ITS LIFE AND HABITS.

Its winter home.—At any time during the winter this stem girdler may be found within the shoots whose tips were cut off in the preceeding May ; three such shoots are shown, half natural size, on the left in figure 17. If such shoots be cut off and split open the condition shown at *a*, figure 18 will be revealed. Beginning at the tip, a tunnel will be found extending down the shoot for from four to six inches ; this tunnel is always packed full of brownish excrement, as shown in the figure. Nearly three-fourths of an inch at the lower end of this tunnel will be found nicely cleaned out and lined with a thin silken cocoon. Within this cocoon inside of the injured shoots the grub or larval stage of the insect passes the winter. In the right-hand shoot at *a*, figure 18 is shown the cocoon at the lower end of the tunnel ; it has been cut away in the left-hand shoot and the grub is thus revealed. At *b*, in figure 18 the lower portion of *a* is shown about two and a half times natural size. The grub or borer is of a glistening straw-yellow color, with the head slightly darker. The thoracic segments are nearly twice as wide as the head and are slightly wider than the others ; they bear six rudimentary feet. From the caudal end of the body there projects upward a peculiar dark brown horny spine, slightly bifid at the tip.*

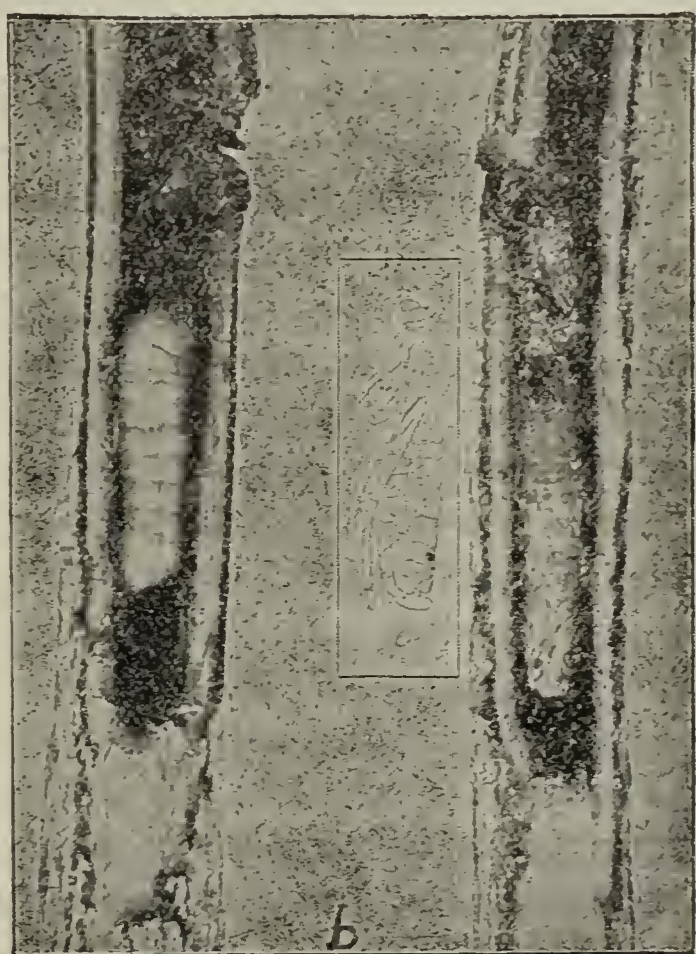
Its spring transformation.—The grub remains in its silken cell unchanged all winter, but when spring opens in April it changes to the curious whitish pupa shown about twice natural size between the two shoots at *b*, figure 18. In 1896, the change from a grub to a pupa took place about April 15th, and about two weeks of the insect's life was passed in the pupal condition. In our cages, the pupae began to give forth the adult insect on May 2d, and all had emerged by May 6th. As the spring of 1896 opened unusually early, the adult insects emerged earlier than

---

* A detailed description of the larva occurs in Bull. 28 of the Mass. (Hatch) Expt. Station ; and an excellent figure of it may be found in Insect Life, VIII, p. 389.

has been recorded in previous records; from the middle to the last of May seems to be their normal period of emergence.

Egg-laying.—As no one had recorded any observations upon the habits of the adult insects, we were much interested to know how the female laid her egg, and why and how she girdled the currant shoots. Therefore, when a male and female emerged in one of our cages on May 2d, a special effort was made to cater to every whim they might manifest. Their "native heath" was imitated, so far as possible, by placing several freshly-cut currant shoots in a roomy cage. The pair of saw-flies were then carefully transferred to this cage. As though apparently appreciating the



18.—a, *two currant stems cut open to show the tunnels made by the larva. The cocoon is shown in the lower end of the tunnel in the right-hand stem, and it has been removed in the other stem to show the larva. Natural size.* b, *the cocoon and larva enlarged about two and a half times. The pupa is shown (enlarged) between the two stems.*

effort that had been made for her comfort, the female began laying eggs within fifteen minutes after she entered the cage. Evidently the insect sometimes begins egg-laying very soon after it emerges, for the female just mentioned had not been out of the cocoon more than two hours; we did not see the pairing of the sexes, and it may not have taken place, for as we shall see later, the female will sometimes lay unfertilized eggs.

In laying an egg, the female takes a position on the shoot a few inches from its tip, with her head towards the tip, and quickly works her long, curved, saw-like ovipositor into the shoot. At figure *b*, plate III, this ovipositor is shown much enlarged and drawn out in position for egg-laying; when not in use it is drawn upward and rests nearly out of sight in a groove in the end of the abdomen. This ovipositor is pushed or sawed in its whole length, and the egg is then quickly forced along between the two blades of the ovipositor and is deposited in the pith of the shoot, as shown much enlarged at *d*, plate IV. The ovipositor is quickly withdrawn, and the whole operation of laying an egg is accomplished in about a minute.

The egg is of an elongate-oval shape, of a yellowish-white color when first laid, about a millimeter (1–25 of an inch) in length, of a delicate structure, and without any characteristic sculpturing. In a day or two after deposition, transparent areas appear at both ends of the egg, and before hatching the whole egg loses its whitish opaque appearance and becomes transparent so that the developing grub can be plainly seen inside.

The slit cut by the ovipositor when an egg is laid is so small that it can scarcely be found even with a hand-lens until about two days after it is made. By that time nature, in her efforts to heal the wound has caused an increased growth around the slit, and there is thus a slight elevation on the shoot at that point. The egg-slit is readily seen on the lower part of the enlarged shoot shown at *c* on plate IV. Most of the eggs are doubtless laid in the latter half of May; some are not laid until June, as we received several on June 8th that had been laid only a few days.

How and why the shoot is girdled.—Immediately after the operation of laying an egg in the pith of the shoot is finished, the female walks up the shoot for from one-half an inch to an inch

and deliberately proceeds to girdle it. This is doubtless the most injurious of any of the insect's habits; and yet the manner in which the girdling was accomplished remained a mystery until we had the pleasure of seeing the female cut many shoots in our cages in May, 1896. Most writers have supposed that the girdling was done with the jaws of the insect, but our observations show that it is done entirely with the saw-like ovipositor.

A female is shown, natural size, in the act of girdling a currant shoot at *a*, plate IV. She first forces her ovipositor its whole length into the shoot. When she withdraws it, however, she does not pull it straight out, but twists it to one side so that it is held at right angles to the body, and then makes it saw its way out. As the ovipositor is curved, its tip first appears through the bark of the shoot off at one side from where it was forced in, and the rest of the "saw" soon comes through leaving a smooth, somewhat curved cut forming a part of the circle around the shoot equal in length to about the length of the ovipositor. The enlarged, recently cut shoot shown at *b*, plate IV, well illustrates the nature of these cuts. Without moving from her position, the female usually again inserts her ovipositor very near where she did the first time, but twists it the other way thus making two cuts extending in opposite directions from one point. She then moves around the shoot until she finds the end of one cut, and proceeds in the same manner to cut another slit. She continues this process of moving around the stem and cutting new slits from the ends of those just made, until the girdle of cuts is complete, or nearly so. We have repeatedly seen a female lay an egg in a minute and in the next four minutes girdle the shoot a short distance above the egg. Sometimes the girdling is so complete that the tip falls of at once, but usually a portion of the shoot remains uncut and the tip may remain attached for sometime, especially if the shoot is a large and vigorous one. At *b*, plate IV, the ends of the girdle did not quite meet; and in some cases the female lost her bearings to such an extent as to continue the girdle of cuts in a spiral direction so that the last cut was above and nearly an eighth of an inch from the first one. Sometimes the female did not first make two cuts from the same point, but at once moved around the stem and made the second cut at

the end of the first, and so on around. Usually four or five cuts were sufficient to girdle a shoot.

It was very interesting to watch so deft and quick a worker as this insect when she was girdling a shoot. She was not easily disturbed when once her work was begun. We have seen one female girdle four or five shoots in an hour in our cages. Of course, the number of tips one insect will girdle, depends upon how many eggs it lays. One female in our cages girdled fourteen shoots and was then accidently drowned. A careful examination revealed four more eggs in shoots that she had not girdled, and we found ten eggs in her abdomen; thus one female is capable of laying at least thirty eggs or may girdle thirty currant shoots. Much damage might thus be done by only a comparatively few of the insects in a currant plantation.

Doubtless the object of the girdling of the shoot above the egg is to cause a cessation of the growth, and thus prevent any injury which might come to the delicate egg or young grub from the vigorous growth which currant tips make in the spring. Yet in spite of this precautionary habit of the mother, many of her young never develop, as we shall see.

Habits of the borers.—Some of the eggs laid by the insect in our cages hatched out the grubs in about eleven days. The minute borers at once began feeding upon the pith of the stem, and tunneled their way downward in the pith, as shown in the left-hand shoot in figure 19. They seem to feed almost entirely upon the pithy part of the shoot; often enough of the woody portion remains to sustain sufficient life in the shoot to develop buds all along the sides of the tunneled portion, as shown in figures 18 and 19. The excrement voided by the borers remains in their tunnels, filling them full of a dark brownish mass, as illustrated in the same figures. If an injured shoot be split open at any time between June 1st and September 1st, the borers may be found at work within their tunnels.

The great mortality among the eggs and young grubs.—Our observations agree with those recorded by Mr. Marlatt (Insect Life VII., 388) in regard to the failure of many of the eggs and young borers to develop. The material sent us in the spring of 1896, indicated that not over 15 per cent of the eggs laid the preceeding

year had developed full grown borers; in most cases the eggs apparently did not hatch, as no tunnel had been begun in the pith, but in some cases the borers got nearly half grown before they succumbed. As Mr. Marlatt stated, the reason for this great mortality is not apparent. He suggested that it might be due to the fact that the cultivated currant, on account of its difference in growth or greater luxuriance, is not as suitable to the insect as wild currants or allied plants, which were presumably its original food plants.

Another explanation of this great mortality may be the fact that an unfertilized female will lay eggs and girdle the shoots as freely as any other female. We demonstrated this fact in our cages last year, but we were not able to definitely determine whether these unfertilized eggs hatched or not.

19.—*Currant shoots split open to show the character of the tunnels made by the borers. One-half natural size.*

However, the fact that there is such a great mortality among the eggs and young grubs of this insect, is of but little practical importance to the currant grower, for in the girdling of the shoots, the pest does its principal injury.

Extent of the tunnels of the borer, and its preparations for the winter.—The grubs begin their work of tunneling down the pith of the girdled shoot as soon as they hatch in the latter part of May. Although the borer continues to work in the pith for about three months, its tunnel rarely extends more than six inches from the point where the shoot was girdled. In one instance where three shoots branched off, as shown in figure 19, a borer tunneled down to the base of one shoot and then across the main stem and part way up another shoot, where it met its death from the attacks of one of its enemies.

About September 1st, the borer begins to make preparations for the winter and for its further transformations. It cleans out the

lower end of its burrow for the distance of about three-fourths of an inch, and also eats a passage way through the woody portion of the stem out to the outer layer of bark which soon dies and sinks in slightly at this point. This passage way is partly filled with excrement or "frass," and the grub then proceeds to spin a thin silken cocoon about itself within which it remains as a grub all winter. These winter preparations are well illustrated at *b*, in figure 18. Sometimes the small dead sunken area of bark covering the passage to the cocoon may be readily detected in winter or spring on an injured shoot. This passage-way enables the adult insect (the saw-fly), to easily make its way out from the cocoon in May.

NATURAL ENEMIES.

The eggs embedded in the pith of the shoots, and the borers as they tunnel their way down the pith, seem to be beyond the reach of their enemies. But the necessity of eating a passage-way to the outer bark to provide for the emergence of the adult insect affords an opportunity which their little foes seem on the alert to secure. Nearly one-third of the full grown borers sent us in the spring of 1896, had been attacked and killed by tiny hymenopterous parasites, evidently after they had spun their cocoons. In every case the little foes had doubtless broken through the thin door opening into the passage-way leading to the cocoon, and had inserted their eggs into the body of their helpless victims. These eggs hatched out maggots which lived at the expense of the body of their host. When full grown the little maggots spun their silken cocoons within the larger cocoon made by the borer. In one case five of the tiny Braconid parasites (*Bracon apicatus* Prov.) emerged from one cocoon of the currant stem-girdler. Curiously enough the parasite nearest the passage-way emerged first, and the others followed in regular succession; we saw one emerge, and upon examining the cocoon next behind, found the adult parasite all ready to appear, while in the next cocoon, we found the insect still in the pupa state. It is to be hoped that this little enemy will continue its good work among the grubs of this new currant pest.

HOW TO CONTROL THE INSECT.

The currant-stem girdler can not be reached at any time or in any stage with a spray. Fortunately, however, its habits are

such that it can be easily controlled by other means. The girdling habit of the adult insect (see the frontispiece), which causes the tips of the young shoots to wilt, die, and drop off in May, makes it easy for currant growers to determine whether the pest is present in their fields, and also just where to apply the remedy. As the egg is embedded in the shoot less than an inch below where the girdling is done, and as the grubs rarely tunnel down the pith to a depth of more than six inches, if the injured shoots be cut off at least eight inches below their tip and burned, all traces of the insect will be effectually destroyed. Only two or three inches of the tips need be cut off, if it is done in May or June, soon after the girdling is done. The cutting and burning of about eight inches of the tips of the injured shoots at any time of the year, even in winter, will prove a practical and effective remedy for this new pest.

BIBLIOGRAPHY.

1861. Norton. Proc. Boston Soc. Nat. Hist., VIII., 224. Original description of the insect.

1862. Fitch. Seventh Rept. on N. Y. Insects, p. 852. Description of adult.

1869. Norton. Trans. Am. Ent. Soc., II., 346. Description of adult.

1887. Cresson. Cat. of Hym. p. 172.

1888. Lintner. Fourth Rept. on N. Y. Insects, pp. 17, 47, 189. First account of the work of the insect.

1890. Lintner. Sixth Rept., p. 190. Specimens received.

1891. Riley. Insect Life, III., 407. Identification of the currant-stem girdler.

1892. Claypole. Can. Ent. XXIV., 273. Notes on the insect in Ohio.

1893. Lintner. Eighth Rept., p. 166-168. Review of what was then known of the insect; Ninth Rept., p. 461. Specimens received.

1894. Marlatt Insect Life, VI., 296-301. Detailed, illustrated account of the insect.

1894. Lounsbury. Bull. 28, Mass. (Hatch) Expt. Station, p. 20. Illustrated descriptive account.

1895. Marlatt. Insect Life, VII., 387-390. Detailed, illustrated account of early stages and habits of the insect.

1897 Lintner. Eleventh Rept., p. 284. Specimens of the adult received May 11th, 1895, from Corning, N. Y.

THE RASPBERRY-CANE MAGGOT.

Pho bia sp.

Order DIPTERA ; family ANTHOMYIIDÆ.

20.—*A raspberry shoot attacked by the raspberry-cane maggot. Natural size.*

Recently a new insect pest has appeared in many raspberry plantations in New York state. It attacks the new shoots in the spring, and in one field sixty per cent of the new growth was killed by the insect in 1895. We first learned of its ravages in our state in May, 1895, when specimens were sent to the insectary from two localities in central New York, Spencer and Cortland. Raspberry plantations in the vicinity of Ithaca, N. Y., were at once examined with the result that in some cases one-third of the new shoots were being killed by the pest; it was also nearly as destructive at Ithaca in 1896.

Raspberry growers should therefore at once familiarize themselves with the work of this new insect enemy, so as to be able to intelligently combat it whenever it may appear in their plantations.

INDICATIONS OF THE PRESENCE OF THE INSECT.

This raspberry-cane maggot attacks only the new shoots which appear in the spring. The results of its work are very conspicuous, and raspberry growers can thus easily determine if the insect is present in their fields. Three injured shoots are represented, natural size, in figures 20 and 21. These figures show that the tips of new shoots attacked by the insect wilt and droop; the stem of this tip shrinks, turns dark blue in color and finally dies. The wilted tip may be easily broken off at a certain point. If the shoot be carefully examined at this point it will be found to have been girdled by the insect from the inside; how this girdling is done will be described in telling the life-history of this pest. Sometimes a very vigorous shoot will continue its growth from side buds, thus forming a branched cane, but usually the injury to the tip results in the death of the whole shoot. In one case the terminal tip and the tips of three of its side shoots had all been killed by the insect.

The pest begins its destructive work as soon as the shoots appear above the ground in the latter part of April, and its work continues during the whole of May. All sizes of the new shoots are attacked; those in figures 20 and 21, and at *b*, plate V, are represented natural size.

Thus when raspberry growers find the tips of new shoots wilted and drooping in May, it is an indication that this new insect pest is at work in their fields.*

THE APPEARANCE OF THE INSECT.

Although raspberry growers will have no trouble in discovering the work of this pest, only the most careful observers will doubtless ever see the adult insect. So close is the resemblance, that the ordinary observer would say that the little flies, which may be seen on the new shoots in May, were simply house-flies. But a careful study of one of the flies, shown much enlarged at *a*

*The raspberry-cane borer (*Oberea bimaculata*, causes the tips of the growing canes to wilt and droop in a similar manner, but this insect does not begin work until considerably later, in June. Thus the work of the two insects need not be confounded in our state.

plate V, would reveal many differences. A detailed description of this fly is unnecessary here. It is a grayish-black, two-winged fly, not quite so large as, but closely resembling the well-known house-fly, of which it is a near relative.

The progeny which hatch from the eggs of flies are known as maggots. To see the young, or the maggots, of this raspberry pest, it will be necessary to carefully split open an injured shoot; in June the maggot will usually be found below the girdle in the lower portion of the shoot. The maggot is slender, white, smooth, footless, and measures from 8 to 10 mm. in length when full-grown. Its black hook-like mouth parts may be indistinctly seen through the semi-transparent skin of the head. Its blunt caudal end has around its margin several small fleshy pointed tubercles, and from the centre project the two elevated brown spiracles.

ITS NAME.

This new raspberry pest belongs to that peculiar order of insects —the true flies—known as the *Diptera*. It is one of the Anthomyiians, and is thus closely related to the cabbage and the onion root-maggots discussed in bulletin 78. In 1886, Mr. Fletcher bred the adult insect, but did not have an expert determine its name. Others who have noticed its work have failed to get the fly. We also failed in our first attempt to breed the insect in our cages, but finally succeeded in obtaining several flies from material collected in the field early in the spring. As the females of many of these Anthomyiian flies are so near alike, it is necessary to study the males to get specific characters for determination. We sent two males to a specialist in England, Mr. R. H. Meade, but they arrived in such a mouldy condition that it was impossible to determine their name, except that they doubtless belonged to the genus *Phorbia*; this is the same genus to which the cabbage and the onion maggots belong.*

*Mr. Meade wrote us: "The two Anthomyiids which you sent me belong to the genus *Phorbia*; but do not seem to be identical with any European species that I know of. They are so covered with mould, however, that most of their characteristic features are destroyed."

Thus this new raspberry pest may also prove to be new to science and therefore as yet unnamed.

HISTORICAL.

The first record we find of any maggot working in raspberry shoots is the statement of Professor Cook that he found "a maggot working in the succulent growth of a raspberry cane" in 1886, at the Agricultural College in Michigan ; this was doubtless the same insect as the raspberry-cane maggot under discussion. The next year, what was probably the same insect, was observed at work in Canada, by Mr. Fletcher ; he recorded a very brief but accurate account of its habits. In 1890-'91, a raspberry-cane maggot was seen in some West Virginia plantations. In 1894, apparently the same pest destroyed nearly half the new shoots in a raspberry field at Lansing, Mich.; and was also reported as doing considerable damage in the vicinity of Costello, Pa During the past two years it has injured a large percentage of the new shoots in the raspberry plantations of central New York ; in 1895, Dr. Lintner received many infested tips from Adams, Jefferson Co., N. Y.

DISTRIBUTION AND FOOD-PLANTS.

From the above historical review, we learn that this new raspberry pest seems to have thus far attracted attention only in Michigan, New York, Pennsylvania and Canada. All observers report that it is apparently as yet confined to limited localities. Its spread will doubtless be rather slow ; the flies may go from one field to another, and a few of the maggots or puparia may be transported in stock shipped from infested fields. Although we have seen its work only in Tompkins, Cortland and Tioga counties in our State, yet we are quite sure, from conversations with raspberry growers, that it occurs in many other localities.

The insect works in the new shoots of both red and black raspberries, and no other food-plants have been recorded.

THE LIFE-HISTORY OF THE INSECT.

In the latter part of April, when the new raspberry shoots are a few inches in heighth, the adult insect—the fly shown much enlarged at *a*, plate V—appears and soon begins laying eggs.

Egg-laying.—The comparatively large, prettily sculptured, elongate, white eggs of this pest are loosely placed near

the very tip of the shoot in the crotch formed by the bases of the tip leaves; at *c*, plate V, is shown one of the eggs much enlarged, and at *d*, are represented three eggs, natural size, in the position in which they were laid. As the fly is smaller than a house-fly, these eggs are comparatively large ones for such an insect, and would thus indicate that one female fly does not lay a large number of eggs. How soon the eggs hatch, we did not determine; it is doubtless but a few days.

Work of the maggot.—The little white maggot which emerges from the egg, crawls down the shoot for a short distance (less than an inch), and then burrows its way into the pith of the shoot. The entrance hole of the maggot is usually quite conspicuous, as the surrounding tissues turn blackish. After the maggot reaches the pith it proceeds to tunnel its way downward, making a small, somewhat tortuous tunnel in the pith. After tunneling about half the length of the shoot (sometimes this is six inches or more but may be only an inch or two), the maggot works its way nearly out to the bark, and deftly continues its tunnel around the shoot, thus girdling it from the inside; this interior girdle or tunnel shows well in the broken shoots at *b*, plate V. Usually the maggot eats a small hole out through the bark, at some point in the girdle; the use of this opening, we have not determined. The maggot continues feeding on the pith at the point where the girdling was done, and nearly severs the shoot in this way. The shoot in the lower right-hand corner of *b*, plate V, is represented with the bark removed to give a clearer idea of this interior girdling. Usually the maggot girdles the shoot in a spiral manner, sometimes tunneling nearly twice around, as shown on one shoot in the right-hand corner of *b*, plate V.

The part of the shoot above the girdle soon wilts, shrinks in size and droops over as is shown in figures 20 and 21. Soon after the tip droops, a dry rot begins at the girdled point, the wilted portion turns a dark blue color, and the whole shoot usually dries up and dies. Perhaps the maggot could not develop in a growing shoot, and it would also be hindered in its transformation to the adult in such a shoot. This may be the explanation why the insect girdles the shoot.

PLATE. V.—*The raspberry-cane maggot* (*Phorbia* sp.). a, *adult female fly, much enlarged;* b, *raspberry shoots girdled by the maggot, natural size;* c, *egg, much enlarged;* d, *tips of three shoots, each bearing an egg in its natural position in the crotch at the bases of the leaves, natural size.*

After thus checking the growth in May, the maggot proceeds to burrow its way downward in the pith and finally reaches the base of the shoot at or near the surface of the ground. This point is usually reached sometime in June.

Pupation.—By July 1st, many of the maggots had undergone a transformation in the lower end of their burrow. Their skin had hardened, turned dark brown in color, and inside this *puparium*, the insect was passing through the *pupa* stage, preparatory to becoming an adult.

Although the puparium is found in June and July, the adult insect—the fly—does not emerge until the next April. The winter is thus passed as a pupa inside the dead base of the shoot. There is but one brood of the maggots each year.

21.—*Infested raspberry shoots. Natural size.*

NATURAL ENEMIES.

Like most of our injurious insects, this raspberry-cane maggot has its enemies among its own kind—the insects. Instead of the adult insect—the Anthomyiian fly—emerging from some of our puparia, a little four-winged hymenopterous parasite appeared. The indications are that many of the maggots fell a prey to this little enemy in 1895 and 1896. It has been determined as *Idiasta incompleta* Prov. We hope its good work may continue in our raspberry fields.

HOW TO COMBAT IT.

With a little watchfulness this new raspberry pest may be easily checked. Its presence may be quickly detected in May, as its work is then very conspicuous; and this is the only month in

which the insect can be combated practicably and with any success. It is capable of doing much damage, especially on new and valuable varieties.

The remedy is simple. As soon as a drooping tip is seen, either pull up the shoot or cut it off several inches below the girdle and burn it. This method faithfully carried out throughout May, will quickly check the pest. There is no possible chance of getting at the insect with a spray. Simply burn all infested shoots in May.

BIBLIOGRAPHY.

1888. Cook. An. Rept. Mich. Bd. of Agriculture for 1887, p. 450. Records finding an Anthomyiian maggot in a raspberry cane in 1886.

1888. Fletcher. Report for 1887, p. 36. Brief, accurate account of a raspberry-cane maggot. *Anthomyia* sp.

1891. Fletcher. Bull. 11, Ottawa Expt. Farm, p. 24. Account of raspberry-cane maggot (*Anthomyia* sp.) with remedy.

1893. Webster. Bull. 45, Ohio Expt. Station, p. 189. Quotes Fletcher's account.

1894. Davis. Insect Life, VII, p. 199. Describes the work of a dipterous raspberry girdler in Michigan.

1894. Hopkins. Insect Life, VII, p. 201. Had observed the raspberry-cane maggot in West Virginia in 1890–91. An Anthomyiid?

1894. Slingerland. Bull. 78, Cornell Univ. Agr. Expt. Station, p. 485. Evidence that the raspberry-cane maggot is not identical with *Phorbia brassicae*.

1897. Lintner. Eleventh Rept. on Insects of N. Y., pp. 170, 285. Brief account of the work of the insect at Adams, Jefferson Co., N. Y. Review of previous accounts.

MARK VERNON SLINGERLAND.

Bulletin 127. February, 1897.
Cornell University Agricultural Experiment Station,
ITHACA, N. Y.
HORTICULTURAL DIVISION.

A SECOND ACCOUNT OF

SWEET PEAS.

By A. P. WYMAN and M. G. KAINS.

PUBLISHED BY THE UNIVERSITY,
ITHACA, N. Y.
1897.

ORGANIZATION.

BOARD OF CONTROL:

THE TRUSTEES OF THE UNIVERSITY.

STATION COUNCIL.

President, JACOB GOULD SCHURMAN.

Hon. A. D. WHITE	Trustee of the University.
Hon. B. F. TRACY	President State Agricultural Society.
Professor I. P. ROBERTS	Agriculture.
Professor G. C. CALDWELL	Chemistry.
Professor JAMES LAW	Veterinary Science.
Professor J. H. COMSTOCK	Entomology.
Professor L. H. BAILEY	Horticulture.
Professor H. H. WING	Dairy Husbandry.
Professor G. F. ATKINSON	Botany.

OFFICERS OF THE STATION.

I. P. ROBERTS	Director.
E. L. WILLIAMS	Treasurer.
E. A. BUTLER	Clerk.

ASSISTANTS.

M. V. SLINGERLAND	Entomology.
G. W. CAVANAUGH	Chemistry.
L. A. CLINTON	Agriculture.
B. M. DUGGAR	Cryptogamic Botany.

Office of the Director, 20 Morrill Hall.
The regular bulletins of the Station are sent free to all who request them.

BULLETINS OF 1897.

124. The Pistol-Case-Bearer in western New York.
125. A Disease of Currant Canes.
126. The Currant-Stem Girdler and The Raspberry-Cane Maggot.
127. A Second Account of Sweet Peas.

CORNELL UNIVERSITY, ITHACA, N. Y., Feb. 10, 1897.

Honorable Commissioner of Agriculture, Albany:

SIR :—The enclosed report is submitted for publication under the provisions of the Experiment Station Extension bill, and it is a complement to Bulletin 111, issued a year ago this month. This Bulletin 111 was the first experiment station report upon sweet peas. It called forth some harsh criticisms, which were very largely due, I think, to a misconception of the problem at which we were working. Our motives in its preparation were two : to popularize the sweet pea, and to give an account of the varieties which were actually sold by the dealers last year. Our estimates of varieties were often very unlike the estimates which are currently made of them ; and it was charged that many of our varieties must have been very untrue to type or else grown from very poor seed. If this charge was true, it only shows that poor seed was in the market and it is evidence enough that the test was needed. In other words, our effort was to determine the exact merits of the sweet peas commonly offered for sale, not to grow the strains of fanciers and plant-breeders. This fact was stated in the bulletin and the reader was cautioned that our estimates of the varieties were drawn solely from our local tests, as follows : "An attempt was made the past season to obtain all the sweet peas which were offered by American seedsmen. * * * The reader should remember, however, that these opinions are founded solely upon the behavior of the varieties upon our own grounds last year. They are not intended to serve as a general or infallible estimate of the varieties. The accounts of these varieties are all made directly from the plants as they grew on our grounds, uninfluenced by published descriptions."

Having grown the sweet peas of the retail seedsmen last year, we have this year turned our attention to the types and strains of the experts and breeders. It is evident, therefore, that the descriptions of this year are not comparable with those of last year ; but the sweet pea lover may be interested to study the dissimilarities in the accounts of the two seasons made from seeds from different sources. In order that there should be as great uniformity as possible in our own work of the two seasons, we have grown the peas of this year upon the same ground which

we used last year (although it was in better condition), and Mr. Wyman has again taken notes, Mr. Hutchins, C. C. Morse & Co. and the Sunset Seed and Plant Co., supplied us most generously with seeds and have been most helpful with suggestions.

It may be well to repeat that these estimates of the varieties of sweet peas are those which have been formed solely from a most careful study in the experiment patch at Ithaca. We did not make the experiment as a mere variety test, and we do not care whether anyone accepts our estimates of varieties or not. We have tried to write the truth as we have been able to see it, hoping that the record may be a contribution to the history of the evolution of the sweet pea. The lists are capable of showing the student how far the flower has been developed, and what measure of satisfaction he may expect in the growing of it. Neither are we desirous of breeding new varieties. That is not our mission, and there are others who can do it much better. We have made a record of what the flower is and what may be expected of it; and now we must hurry on, for we have lots to do.

Our peas were sown April 20, upon a clay loam which is low enough to keep moist through the season. Until the plants began to bloom freely, the land was kept in a thorough state of tillage. Fig. 22 shows the plantation as it looked July 20, before the heaviest bloom had appeared. In this plantation, 176 separate samples of peas were grown. The study of these peas was put in the hands of two mature and capable students. Mr. Wyman did the greater part of the work upon the former test. During the present season he represented us at the sweet pea show at Springfield, Mass., whence we sent a collection of blooms representing the common run of the plantation. Mr. Kains is a post-graduate student in the College of Agriculture. The work of these young men has been carefully supervised, and I endorse the results, although, of course, it is impossible for any two persons to arrive at identical conclusions respecting the merits of given varieties.

We have no further information to give for the cultivation of sweet peas than was given in our former bulletin, except to say that the ground may easily be made too rich for them. Several persons complained to me last year that their sweet peas grew luxuriantly but did not bloom. They had used too freely of

stable manures, and the plants ran to vine. The sweet pea is one of that class of plants (the leguminous) which appropriates nitrogen for itself, and heavy applications of nitrogen are therefore not needed. Another type of complaints was to the effect that young plants died after having made a good growth of several inches. Inquiry revealed the fact that in every case the plants had been frequently watered from a watering pot. Just enough water had been applied to keep the surface of the ground soggy, and the plants had damped-off. Plant lovers should remember that one good watering which wets the ground clear down is worth a dozen dribblings. It is rare that a sweet pea bed should be watered oftener than once a week in good soil; and if the seeds are got in early, a frequent stirring of the surface soil with hoe or rake is better than watering at all.

In the forcing of sweet peas we have made two tests in a very small way. A year ago we sowed seeds in a bench in a chrysanthemum house on October 24, and they began to bloom Feb. 20, and continued to blossom well for six weeks. The bloom was not so profuse as it is out of doors, but the flowers were just as large and handsome and fragrant. Fig. 23 shows a corner of sweet peas as they looked early in March. We also had a most profuse bloom in a row forty feet long during last April, May and June. The seeds were sown in pots, and when chrysanthemums were taken off (from a solid bed) on December 10, the peas were turned into the soil from 2½-inch pots. They were blooming freely when sweet peas were quoted as high as carnations. Last fall we sowed seeds in the same house September 8 in a solid bed. The plants grew well, and a single truss opened on November 30. The weather then closed in for a characteristic Ithaca winter, and the sun did not shine again for a full day for two months, and no other flowers appeared until early in February. If the weather had remained bright, I see no reason why we should not have had good flowers for Christmas.

The history and something of the evolution of the sweet pea are traced in our Bulletin 111; but Rev. W. T. Hutchins, Indian Orchard, Mass., a long-time student of the flower, has given me his conception of the evolution of the modern varieties in a graphic form, which is here reproduced:

Original Purple and Blue.

1. Purple and Blue, continued . . . Imperial Blue=Invincible Blue=Capt. of Blues =Madame Carnot (Laxton '92.)
(Eckford '86.) (Laxton '89.) (Eckford '90.)
Waverly (Eckford '92.)

Old Purple and Blue probably began to stripe about this time

Eckford Princess of Wales stripe '85.

2. Imperial Purple = Black=
(England '67.) (Old English Trade Lists.)
Invincible Black=Bronze Prince=
(Carter '80.) (Eckford '82.)

Purple Prince (Eckford) = ... Monarch (Eckford '91.)
Duke of Clarence (Eckford '93.)

Boreatton= (Eckford '87.) . . . . Senator (Eckford '91.) . . . . . Stanley (Eckford '94.)

Indigo King (Eckford '85.) . . . . Shahzada (Eckford '97.)

Purple and Brown stripe probably began here.

The reader of Bulletin 111 may remember that Waldo C. Rohnert, sweet pea specialist of the firm of C. C. Morse & Co., contributed a sketch of his efforts to breed varieties by crossing. The following are further remarks by him along the same line:

"Some people have no idea how hard it is to get a new variety in sweet peas, that is, new and distinct, with merit. In roguing time I can go over our fields and find 'off' plants, but they do not possess merit. The color is probably of a different shade or the form is a little different. But they are all 'off' types. New varieties are brought about only by a good deal of careful work. Last summer I spent many a day in the hot sun crossing the different varieties and in consequence have a trial ground this year that is truly odd to look at. Most of it is common Blanche Ferry and the Light Blue and Purple. It is very strange how strong the blood of these two varieties exists in the new varieties. Last year I spent a good deal of my time crossing on Cupid and obtained crosses of over thirty different varieties on this little imp. Now the result is that all varieties that have red or pink in them come a Blanche Ferry of the ordinary Blanche

Ferry growth, and all varieties that have blue in them come a Light Blue and Purple. This is always the rule when crossing on Cupid. Here and there are plants of Cupids, but these come because the crossing was not made perfectly. It is very hard to cross on Cupid as the pollen breaks away when the bud is very small. Several years ago I put Cupid on Venus and last year I got a weak Blanche Ferry of ordinary Blanche Ferry growth. Last year I put Cupid onto this cross and now I have a Cupid again. This is three-fourth Cupid blood and one-fourth Venus, and still it does not show any of the latter. It cannot be distinguished from the thousands of Cupids we have growing.

"Of the other crosses, that is, those on the taller varieties, the results are also discouraging. There are several new things, however, that save the whole summer's work from being a total failure. My stock of Penzance on Venus '95 was put onto Coquette (a plant which I found last year and a variety which Eckford will introduce in this country next year) brought me a variety with a pale pink standard and white wings. It has the grandiflora form and is very pretty. Lottie Eckford on Eliza Eckford brought me a flower like the former, but color of reddish mauve. Last year I had an 'Improved Royal Robe.' It was a result of Penzance on Venus and was the finest stock on Royal Robe I ever had. This year it broke up into many new and several old varieties, but all of very fine form and color, such as buff, with a suggestion of pink, a rose edge, a pink edge on white ground (Eckford's Countess of Aberdeen), a pink edge on buff ground; there are fine shades of white, also improved Ovids, Royal Robes, Lady Penzance, Blushing Beauty, etc. It is truly the finest mixture in sweet peas; there is not a flower of poor form or color in it. We will also have for next year's introduction a pink which will correspond to Grey Friar. It is better than the latter, as the color in much finer."

It is hoped that this bulletin may contribute something to the joy of rural life by interesting persons who have a rod of land to spare, in the delights of plants and the restfulness of nature-study.

L. H. BAILEY.

22.—*The Cornell sweet pea patch, July 20, 1896.*

A SECOND ACCOUNT OF SWEET PEAS.

I. Notes upon Sweet Peas (*A. P. Wyman*).

Someone asked Mr. Burpee at the Springfield Sweet Pea Show what are the important points to be observed in judging the value of varieties of sweet peas. He replied by quoting from Eckford, but arranged his points in different order : "form, size, substance, and color." He, of course, looked at the matter from the seedsman's point of view. To him commercially, color was the least thing to be considered. The general observer would see color only, and experience only a vague satisfaction or dissatisfaction if the other points were not what they should be. But Mr. Burpee had good ground for putting color last, for this, tolerably sure to be good anyway, is absolutely worthless unless placed on a canvass suited to receive it.

The various forms which the sweet pea assumes easily fall into four classes. One class is the large flower which bends and curls its standard forward into a hood, like the Countess of Radnor. Another large flower, as Gaiety, spreads itself out into a broad, round, expanded form, but without a stiff effect. Still another bends or reflexes the sides of its banner backward in a manner not so pleasing, and if the substance is poor, in a manner which is almost ugly as in Fairy Queen. Last, there is the stiff, erect blossom, the smallest type, from which all the varieties have sprung, as Carmen Sylva. In connection with this expansion and hooded character and reflection, must be considered the shape of the base of the standard. In the last or old natural form, and to a greater or less extent in the reflexed, the base is wedge-shaped. In such case, the banner cannot help falling backward, because there is no structure to pull it forward into place. In the expanded and hooded forms, the base is different. Here it is not only straight horizontally or truncate, but in the hooded form is drawn down, giving an ear-like or auriculate shape. This explains the characters of the two expanded and hooded classes. The broad truncate base is stiff and pulls the edge of the blossom forward tightly into place, or if it is auriculate, it is still stronger, and curls the edge still farther forward into a hood. There are

two other variations which cannot be classified and which occur in the poorer forms only, as a rule. These are the occurrence of a notch at the top, or really the emphasis of a minute notch already there, as in Emily Henderson, or else a notch or sinus at either or both sides of the standard, as in the case of the Butterfly.

Three sizes are commonly accepted and will be found accompanying the classification above. The small, as in Captain Clarke, is that of the old natural form. The medium size is the one usually found in the reflexed form, like the Boreatton. While the large size of Senator and Dorothy Tennant is that of the expanded and hooded classes.

Substance, that is, the quality of texture which enables the flower to retain its shape, has arbitrarily been put under the heads of good, fair, and poor. Those varieties which keep their blossoms fresh and rigid in the heat of midday are called of good substance. Those whose blossoms curl and wrinkle badly are called poor, and the fair are various degrees between. The value of substance as affecting the beauty of the flower is not appreciated until one gives close study to the sweet pea. A flower without good substance or texture is absolutely ugly. Without strong substance it would appear that expansion and hooded character could not remain, and the flower would fall back into the reflexed class where, with its large size, it would curl and wrinkle until, in the lowest types, the flowers become worthless.

It is now possible to give the characteristics of the four classes into which most varieties of sweet peas seem to fall. This idea of classifying them was suggested by Mr. Hutchins, who based his classes upon the shape of the base, and the degree of substance or size which would result therefrom. A full statement of these classes, as they seem to work out from the studies of the Cornell tests, is as follows:*

I. The old natural form, with a wedge-shaped base, erect, expanded standard, and small size, as Delight and Carmen Sylva.

II. The reflexed form, with a more or less wedge-shaped base, the standard with its sides more or less curled backward or re-

*Another classification is given in the "Sweet Pea Review" of the Sunset Seed and Plant Co., San Francisco,—a booklet which is invaluable to anyone who desires full descriptions of varieties.

flexed, of medium size, and of substance rarely good, as Firefly, and Fairy Queen.

III. The expanded form, with a truncate or somewhat auriculate base, a broad, erect, rounded standard, large size, and fair to good substance, as Gaiety and Ovid.

IV. The hooded form, with an auriculate base, a hooded or half-hooded standard, large size, and fair to good substance, as Her Majesty and Emily Eckford.

These classes, of course, are not divided by hard and fast lines, but no variety in the experiment has yet been found which either did not fall or tend to fall into one of them.

We are now, perhaps, better prepared to understand Mr. Burpee's preference in putting color last in the scale of points. It is because form brings with it a number of other qualities, all of which make a flower a good one or a poor one. There is, however, a deeper reason for this preference for form which it would need an artist to explain. The eye is as much pleased with beauty of form as with color. The mere outline of a blaze of light carries with it a certain effect. Ruskin tells us that the old Gothic windows in the best days of Gothic architecture owed their characteristic beauty to the form of the aperture in which the stained glass was placed and not to the decorations about that aperture. It would seem to be the same with the sweet pea. Unless there is a full blaze of light from a full rounded curve, the effect in part is lost. Then, too, the variations in light and shade in the complexity of the flower are no small addition to the complete rounded effect. Last, the blossom must be large enough to be appreciated, but still not so large as to lose that delicacy which is one of its greatest charms.

The variety of color which is to be found in the sweet pea is wonderful. Since the four original varieties were sent out, numerous additions, to say nothing of improvements, have been made. At the same time, there are a few stock types, about which the others cluster. If one wishes to enjoy the best of all there is in the sweet pea without growing what would appear to be an amateur variety test, it can easily be done by selecting the best representative of each type of color and growing them and them only. All classes and colors may be easily divided into

nine types each of which has a general characteristic of its own. By beginning with the dark purples, a graduation may be made to the whites, and from the whites again on to the bright reds. The dark purples may be taken as the first class, represented by Waverly. The striped purples may be considered second, of which Senator is an example. The lavenders may be called third, represented by the Countess of Radnor. The whites come fourth, of which Blanche Burpee and Emily Henderson are the most famous. The primroses, as Mrs. Eckford, may be counted fifth. Sixth come the white shaded with pink, as Blushing Beauty. Seventh are the striped pinks, as Mrs. Joseph Chamberlain. The orange pinks are eighth, as Lady Penzance and Meteor. Last are the rose pinks, which may be subdivided, one class a pure pink, as Her Majesty and Royal Robe, the other having orange besides the rose, as Firefly and Miss Hunt. Here is wide range of color, and of a high quality, all gained by simply growing nine or ten varieties of sweet peas. Respecting double sweet peas, it may be said that the doubles are generally strong strains and give a profusion of large bloom, most of which, fortunately, is single.

It is a great advantage, of course, in the purchase of anything to know just what to get, and when a wise man purchases, he gets the very best. At the Springfield Show, Mr. Hutchins and Mr. Burpee selected independently the four varieties which each considered the best. Mr. Hutchins' choice was, Her Majesty, Mrs. Eckford, Lady Penzance, Ramona. Mr. Burpee's choice agreed with this as to the first two, Her Majesty and Mrs. Eckford, but chose for the others, Mrs. Joseph Chamberlain and Blanche Burpee. A selection by either of these men, of course, carries much weight, but when they agree upon any one or two varieties as being the best of all, their choice is not to be disputed. Besides this, the Station experiment plot has been closely studied and the best representatives in all points of each of the classes which have been named above as they have grown here this summer, have been recorded. They are (in my opinion) :—

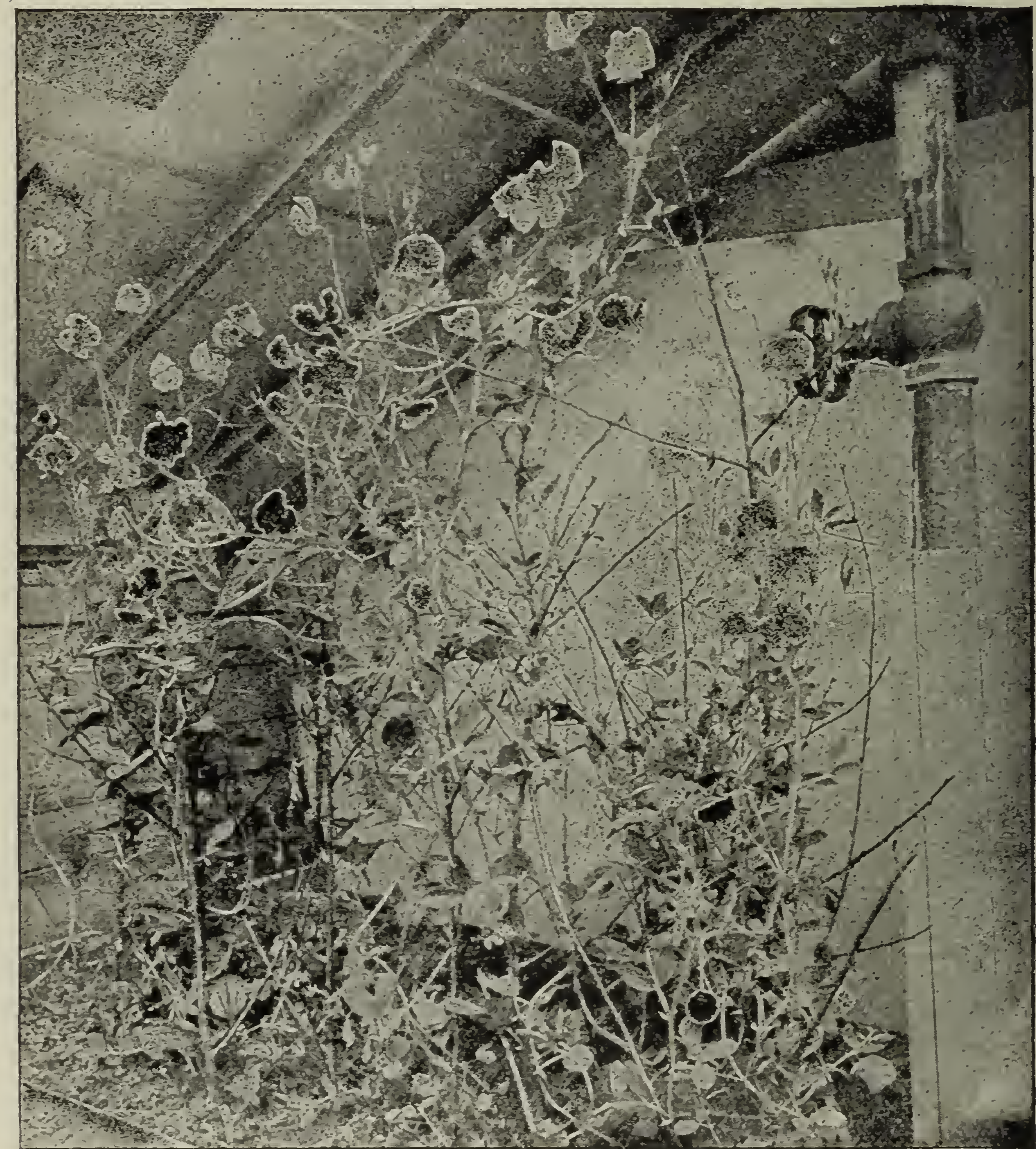
I. Dark purple.	1. Waverly.
	2. Duke of Clarence.
II. Striped purple.	1. Gray Friar.
	2. Juanita.
	3. Senator.

III.	Lavender.	1.	Countess of Radnor.
		2.	Lottie Eckford.
IV.	White.	1.	The Bride.
		2.	Emily Henderson.
V.	Primrose.	1.	Mrs. Eckford.
VI.	White flushed with pink.	1.	Blushing Beauty.
		2.	Katherine Tracy.
		3.	Eliza Eckford.
VII.	Striped or flaked pink.	1.	Ramona.
		2.	Mrs. Joseph Chamberlain.
VIII.	Orange-pink.	1.	Lady Penzance.
		2.	Meteor.
IX.	Rose-pink.	1.	Her Majesty.
		2.	Splendor.
IXa.	Rose-pink shaded with orange.	1.	Firefly.
		2.	Princess Victoria.

These results are simply those of this experiment plot. Blanche Burpee, I suppose, ought to have come before Emily Henderson in the whites, but it has not come up to expectation here and consequently must drop out. No doubt the same is true of other varieties. Nevertheless we hope that in this list is the cream of most that is good in sweet peas. It is said that Emily Henderson is inferior to Blanche Burpee because it is notched, does not spread so freely, curls or reflexes to some extent, and has a tinge of green as the latter does not. Nevertheless, with us Blanche Burpee is not a useful flower. While full grown individual blossoms possess all the qualities said of it, most of the flowers do not spread or else fade before maturity, and consequently do not act the part expected of them. Of the striped pinks, Ramona and Mrs. Joseph Chamberlain ought really not to be compared, as they are of a wholly different shade of pink. Ramona may be put first only because it is perhaps the more refined. Mention of the dwarf Cupid must not be omitted. Cupid is not wholly a thing of beauty; Mr. Hutchins, however, considers it well worth the introduction historically. He wants it as the basis of future crosses with the tall varieties, that one may be enabled to procure the blossoms at a more convenient height.

I am greatly indebted to Mr. Hutchins for the time and patience spent with me over the flowers at the Springfield Sweet Pea Show. The flowers certainly deserve the work and enthusiasm which Mr. Hutchins has given to them. Although careless and

free, they are the product of much labor and thought. Their requirements, while not burdensome, are exacting. The earliest springtime is none too early for them to see the ground. They are sown deep or shallow according to the character of the soil, but so that their roots will be cool. They require the full sunshine to warm them, fertility to feed them, and rain to give them drink. Given these amenities, the sweet pea becomes the pride of the garden and the joy of the home.



23.—*Sweet peas in winter.* (See page 65.)

II. DESCRIPTIONS OF THE VARIETIES GROWN AT CORNELL IN 1896. (*A. P. Wyman* and *M. G. Kains.*)

NOTE.—These descriptions were made by Mr. Wyman directly from the Cornell patch in 1896, independently of former descriptions or others' opinions. When his notes were completed, they were placed in Mr. Kains' hands and he was asked to go over the plantation carefully and make whatever comments he thought proper. His comments are placed after Mr. Wyman's and are marked by a dagger (†). It will be noticed that the two men sometimes disagree widely as to the merits of varieties,—a fact which shows how futile it is to try to make any dogmatic assertions upon the merits of plants.

The name in parenthesis is that of the party who supplied us with the seeds. The asterisks (*) denote the Eckfords, and the year of introduction follows in some cases.

It is very probable that climate and season have much to do with the merits of sweet peas. Varieties which were "off" with us, or of mixed type, may have come from the best of seed.

The term "cropper" is used by florists to designate those plants or varieties which produce a heavy yield or crop at a certain time and thereafter flower very little or none. L. H. B.

Adonis. (Morse.)

Poor ; reflexed ; medium size ; poor substance ; color rose-pink ; bloom medium-profuse.

Height Aug. 6, six feet.

Said to be poorest of that color.

† Profuse bloomer, mid to late season.

Adonis. (Hutchins.)

Same as Adonis (Morse.)

Alba Magnifica. (Morse.)

Fair ; expanded, notched, wings at a large angle ; medium size ; fair-good substance ; color white; bloom medium-profuse.

Height Aug. 6, six feet.

† Best all round white in plantation. Better bloomer than Blanch Burpee or Bride, but has too short stems.

Alba Magnifica. (Hutchins.)

Same as Alba Magnifica (Morse.)

† A little better bloomer and has longer stems than above.

Alice Eckford. (Breck.)* 1896.

Good ; reflexed, notched ; large ; fair substance ; color, white lightly flushed with pink ; bloom medium-profuse.

Height Aug. 6, five feet.

† With us like Lemon Queen. Buds greenish yellow ; standard same tint when first opened, changing to the pinkish hue.

America. (Morse.)

Fair; expanded, notched; medium size; poor substance; color, heavily streaked crimson; bloom profuse.

Height Aug. 6, six feet, six inches.

† Crimson and white streaked. Has more crimson than Gaiety, Mrs. Jos. Chamberlain, Queen of the Isles or Red and White Striped, with which it forms a series. Mrs. Chamberlain is the lightest in color.

American Belle. (Breck.)

Is Apple Blossom.

Apple Blossom. (Morse.)*

Good; hooded; large size; good substance; color varies between purplish rose and light purplish pink; bloom profuse.

Height Aug. 6, six feet.

A standard. Would be "very good" if true to type.

† Variable, particularly in wings. Liable to be mottled. Mottling seems to be a seasonal defect or due to fertilizer. See *American Florist*, July 18, 1896, p. 1330.

Apple Blossom, double. (Burpee.)

Very good; hooded; large; good substance; color rose pink; bloom sparse-medium.

Height Aug. 6, four feet, six inches.

Occasionally double.

A good strain of Apple Blossom.

Black. (Morse.)

Poor; reflexed, notched; medium size; poor substance; color, claret, wings purple; bloom medium.

Height Aug. 6, five feet, six inches.

† Bloom profuse toward end of season. Poor at best.

Black and Brown Striped. (Breck.)

Poor; expanded or reflexed, notched; medium size; very poor substance; color, streaked claret, wings streaked reddish purple; bloom medium.

Height Aug. 6, five feet.

† Large size as a rule. Not an attractive variety.

Black Purple. (Breck.)

Is the Black.

Blanche Burpee. (Morse.)* 1895.

Good; expanded or reflexed; medium-large size; fair–good substance; pure white; bloom medium profuse.

Height Aug. 6, three feet, six inches.

Is a disappointment; produced very few fully expanded blossoms, those, however, of good quality.

† Size variable; substance, poor. Wings crumpled, unlike other whites in this respect. Larger than Alba Magnifica; poor bloomer.

Blanche Burpee. (Hutchins.)* 1895.

Same as Blanche Burpee (Morse).

† A little better than preceding.

Blanche Burpee. (S. S. P. Co).* 1895.

Same as Blanche Burpee (Morse).

Height August 6, three feet.

† Largest and best formed white in plantation; better than the preceding; would rank it first of the whites if a better bloomer.

Blanche Ferry. (Morse.)

Fair; expanded, notched, bold; medium size; fair substance; color, standard crimson rose, wings rose purple, shaded or blotched on white in various degrees; bloom profuse.

Height Aug. 6, six feet.

† An early "cropper," much mottled this year. See *American Florist*, July 18, 1896, p. 1330. Burpee's illustration on seed packets shows white wings. Very little white in our patch.

Blushing Beauty. (Morse.)* 1893.

Very good; hooded; large; good substance; color, delicate pink; bloom medium.

Height Aug. 6, four feet, six inches.

Has a little more color than Alice Eckford.

† A favorite; one of the best pinks.

Blushing Beauty. (S. S. & P. Co.)* 1893.

Same as Blushing Beauty (Morse).

Height Aug. 6, two feet, nine inches.

Blushing Bride. (Breck.)

Is Blanche Ferry.

Boreatton. (Morse.)*

Fair; reflexed; medium size; poor substance; color, claret, wings purple; bloom medium–profuse.

Height Aug. 6, four feet, six inches.

† Very poor substance. Bloom profuse toward close of season. Cannot distinguish from Stanley.

Boreatton. (Hutchins.)*

Same as Boreatton (Morse).

Boreatton. (S. S. & P. Co.)*

Same as Boreatton (Morse).

Height Aug. 6, four feet, six inches.

Boreatton, double. (Burpee.)

Very good; expanded; large size; fair substance; color, claret, wings purple; bloom sparse.

Height Aug. 6, four feet.

Did not double.

Same as Boreatton, of better size and substance.

†Some few doubles—both in wings and standard. Has more purple than single Boreatton.

Bride, The. (Lynch.)

Very good; expanded; large; fair–good substance; color, pure white; bloom medium.

Height Aug. 6, five feet.

† About the same size as Blanche Burpee, but wings not crumpled. Poorer bloomer than Blanche Burpee.

Bronze King. (Morse.)

Fair ; expanded, somewhat reflexed ; medium size ; poor substance ; color white flushed or strongly blotched with a coppery hue, wings white or blotched with rose purple ; bloom medium.

Height Aug. 6, six feet, six inches.

Butterfly. (Morse.)

Good ; hooded, with sinuses at the sides ; medium size ; good substance ; color white edged with mauve, flushed with lavender ; bloom medium-profuse.

Height Aug. 6, five feet.

Butterfly, double. (Burpee.)

Good ; hooded, with sinuses ; medium size ; fair substance ; has a little more color than Butterfly ; bloom medium.

Height Aug. 6, four feet, two inches.

Did not double.

† Only a few doubles.

Butterfly Improved. (Morse.)

Good ; hooded, sometimes with sinuses ; large ; fair-good substance ; has less color than Butterfly ; bloom medium.

Height Aug. 6, five feet, three inches.

Sinuses less than in Butterfly.

Butterfly Winged. (Morse.)

Good ; hooded, sometimes with sinuses ; large ; fair-good substance ; has more pink than Butterfly ; bloom profuse.

Height Aug. 6, five feet, six inches.

Wings curl separately.

Light Blue and Purple intermingled.

Captain Sharkey. (Breck.)

Like Invincible Carmine.

Captain Clarke. (Morse.)

Poor ; expanded, erect, slightly notched, wings at a large angle ; small ; fair substance ; color, white unevenly flushed with carmine, penciled with mauve, wings lavender ; bloom medium-profuse.

Height Aug. 6, five feet, six inches.

Captain Clarke. (Hutchins.)

Same as Captain Clarke (Morse).

Captain of the Blues. (Morse.)*

Good ; expanded, erect ; large ; fair-good substance ; color, purple-magenta, wings purple ; bloom medium-profuse.

Height Aug. 6, four feet, six inches.

Captivation. (Breck.)* 1896.

Good ; expanded ; medium size ; fair-good substance ; color, light pinkish purple ; wings rose-purple.

In bud Aug. 3 ; had three blossoms Aug. 7.

Height Aug. 6, three feet.

† Larger than medium ; late.

Cardinal. (Morse.)*

Fair; expanded, erect; medium-large size; poor substance; color, crimson-rose inclined to be blotched, wings purple-rose; bloom profuse.

Height Aug. 6, six feet.

† Small to medium. Cannot see difference between this and Capt. Sharkey.

Cardinal. (S. S. & P. Co.)*

Same as Cardinal (Morse), except the stock seemed to be poorer.

Carmen Sylva. (Hutchins).

Poor; expanded, erect, notched; small to medium size; poor-fair substance; color, white shaded with magenta, penciled with mauve, wings pinkish mauve; bloom medium-profuse; ugly.

Height Aug. 6, five feet, six inches.

† Very poor.

Carmine Invincible. (Morse.)

Fair; expanded; large; poor-fair substance; color crimson, wings purple-rose; bloom profuse.

Height Aug. 6, five feet, six inches.

† Distinct from Invincible Carmine.

Countess of Aberdeen. (Breck.)* 1896.

Not in bloom Aug. 3.

Height Aug. 6, five feet.

† No bloom Sept. 9.

Countess of Radnor. (Morse.)*

Very good; hooded; large; good substance; color, pinkish-lavender; bloom medium. Said to be running back to original blush tint.

Height Aug. 6, five feet, six inches.

† Very large. Bloom more profuse toward end of season. Handsome and distinct. See note under Dorothy Tennant.

Countess of Radnor. (S. S. & P. Co.)*

Like Princess May. A striped-purple intermingled.

Countess of Radnor Improved. (Morse.)

Same as Countess of Radnor. Madame Carnot intermingled.

Crown Jewel. (Breck.)* 1896.

Not in bud Aug. 3.

Height Aug. 6, four feet, six inches.

† Very poor; erect, notched; small to very small size; very poor substance, color, blush-pink with more or less bronzy finish on the standard. Bloom sparse.

Crown Princess of Russia. (Morse.)

Poor; expanded; small-medium size; poor substance; color, white lightly flushed with pink and primrose, wings flushed with pink; bloom sparse-medium.

Height Aug. 6, five feet, six inches.

Said to have a historical value only as being the first of the flushed pinks.

Cupid. (Introd. by Burpee, 1896. See Bull. 111, p. 182).

An interesting dwarf, growing about eight inches high, and worth growing as a pot plant, but of little value in the open. The flowers are small and white, and with us were scattered along through the season, at no time making a show. See page 73.

Daybreak. (Morse.)

Fair ; broadly expanded or reflexed, notched ; medium size ; poor substance, color, white clouded on the back with purplish rose, less clouded on front, with white margins, giving watered effect, wings white, occasionally blotched with rose-purple ; bloom medium-profuse.

Height Aug. 6, four feet, six inches.

Duchess of Edinburgh intermingled.

Daybreak. (Hutchins.)

Same as Daybreak (Morse), but unmixed type.

Delight. (Morse.)*

Fair ; expanded ; small ; fair substance ; color, white with a very light shade of suffused carmine ; bloom profuse.

Height Aug. 6, six feet.

† Poor.

Dorothy Tennant. (Morse.)* 1892.

Very good ; hooded ; large ; good substance ; color, pinkish lavender ; bloom medium-profuse.

Height Aug. 6, four feet, six inches.

† Much like Countess of Radnor, but a shade darker.

Dorothy Tennant. (S. S. & P. Co.)* 1892.

Like Dorothy Tennant (Morse).

Height Aug. 6 three feet.

Duchess of Edinburgh. (Morse.)*

Fair ; reflexed ; medium size ; poor substance ; color scarlet and rose, wings magenta ; bloom medium-profuse.

Height Aug. 5, four feet, three inches.

Duchess of York. (Morse.)* 1895.

Fair ; expanded or somewhat hooded ; large ; poor-fair substance ; color, white delicately flushed and streaked with purplish pink ; bloom sparse.

Height Aug. 6, four feet.

† Very poor bloomer.

Duchess of York. (S. S. & P. Co.)* 1895.

Like Duchess of York (Morse).

Height Aug. 6, four feet.

Duke of Clarence. (Morse.)* 1893.

Very good ; expanded, sometimes hooded ; large ; fair-good substance ; color claret, wings purple ; bloom medium.

Height Aug. 6, four feet, three inches.

Said to be the finest purple.

† Handsomest and largest purple in the patch.

Duke of Clarence, double. (Burpee.)

Very good ; hooded ; large ; good substance ; color claret, wings dark rose purple ; bloom sparse.

Height Aug. 6, five feet.

Did not double.

† Much like Boreatton but has more of a purple effect. Fully two-fifths of the blooms are double.

Duke of York. (Morse.)* 1895.

Poor ; expanded or reflexed, notched ; medium size ; poor-fair substance ; color, wine, wings rose purple ; bloom medium-profuse.

Height Aug. 6, four feet, six inches.

Duke of York. (Hutchins.)* 1895.

Same as Duke of York (Morse), except that Captain of the Blues is intermingled.

Duke of York. (S. S. & P. Co.)* 1895.

Same as Duke of York (Morse), except that the bloom is sparse.

Height Aug. 6, four feet.

Eliza Eckford. (Hutchins.)* 1895.

Very good ; hooded ; large ; good substance ; color white, more or less delicately flushed and shaded with rose, back strongly flaked with rose ; bloom profuse.

Height Aug. 6, six feet.

† Very handsome, and a favorite.

Emily Eckford. (Morse)* 1893.

Good ; hooded ; large ; good substance ; color, pinkish lavender ; bloom sparse.

Height Aug. 6, five feet.

Said that on the third day, the flowers have nearest to blue of any sweet pea.

† Very much like Countess of Radnor, but a poor bloomer.

Emily Henderson. (Morse.)

Good ; expanded, sometimes reflexed, notched, wings at a large angle ; small-medium size ; fair-good substance ; color, white with a greenish tinge ; bloom medium-profuse.

Height Aug. 6, four feet, three inches.

† Poorer bloomer than Alba Magnifica, and not so good a white, but has better stems. Appears like Queen of England but a poorer bloomer.

Emily Henderson. (Hutchins.)

Failed to germinate well.

† One seed grew. Same as above, but had smaller stems.

Emily Henderson. (S. S. & P. Co.)

Like Emily Henderson (Morse), except that the bloom is sparse.

Height Aug. 6, three feet, three inches.

† Smallest white in the patch ; not like two preceding.

Empress of India. (Morse)*

Is Blanche Ferry.

Etna. (Hutchins.)

Poor ; expanded, notched ; medium size ; poor substance ; color, purplish crimson, badly blotched, with darker center and light edges, wings rose purple ; bloom medium.

Height Aug. 6, five feet, six inches.

Fairy Queen. (Morse.)

Poor ; reflexed, wings at a large angle ; small-medium size ; poor substance ; color, white with carmine veins ; bloom medium-profuse.

Height Aug. 6, five feet.

Firefly. (Morse.)* 1893.

Very good; reflexed; medium size; fair substance; color, bright rose pink, sometimes inclined to blotch, wings rose purple; bloom medium.

Height Aug. 6, four feet, six inches.

Not first-class in all points, but best of its kind.

† Pretty, but not large or stable enough. An early "cropper."

Firefly. (Hutchins.)* 1893.

Same as Firefly (Morse), except that the bloom is profuse.

Firefly. (S. S. & P. Co.)* 1893.

Like Firefly (Morse.)

Height Aug. 6, four feet, three inches.

Firefly, *Hooded*. (Morse.)

Very good; expanded, tends to hood; large; fair substance; color, rose-pink; bloom medium.

Height Aug. 6, four feet, three inches.

Larger and better substance than Firefly.

Said to be same as Mars.

Gaiety. (Morse.)* 1893.

Good; expanded; medium-large size; poor-fair substance; color, white streaked with purplish rose; bloom profuse.

Height Aug. 6, four feet, six inches.

† The prettiest streaked bloom in the patch. More purple than the other streaked reds. (See note under America.)

Gaiety. (S. S. & P. Co.)* 1893.

Like Gaiety (Morse.)

Height Aug. 6, four feet.

Gray Friar. (Morse.)

Very good; expanded, slightly hooded; large; fair substance; color, white watered more or less with streaked red purple giving a grayish effect; bloom profuse.

Height Aug. 6, four feet, nine inches.

Evidently sported somewhat.

Purple Prince intermingled.

Harvard. (Breck.)

Is Ignea.

Her Majesty. (Morse.)* 1892.

Very good; hooded; large; good substance; color, soft rose pink; bloom profuse.

Height Aug. 6, six feet.

Ignea. (Morse.)* 1893.

Good; expanded; medium size; fair substance; color, crimson pink, wings purple rose; bloom sparse.

Height Aug. 6, six feet.

Ignea. (S. S. & P. Co.)* 1892.

Like Ignea (Morse.)

Imperial Blue. (Morse.)*

Is Madame Carnot.

† Poorer bloomer than Madam Carnot.

Invincible Blue. (Hutchins.) Saxton, 1881.

Good ; somewhat reflexed ; large ; fair-good substance ; color claret, wings purple ; bloom medium.

Height Aug. 6, six feet, four inches.

† Medium in quality.

Invincible Black. (Hutchins.)

Good ; hooded ; large ; substance fair-good ; color, claret, wings purple bloom profuse.

Height Aug. 6, six feet.

Invincible Carmine. (Hutchins.)

Fair ; reflexed ; medium size ; poor substance ; color, crimson-rose more or less blotched, wings purple rose ; bloom profuse.

Height Aug. 6, six feet.

Said to be practically Cardinal.

† Distinct from Carmine Invincible.

Invincible Scarlet. (Breck.)

Belongs with Invincible Carmine.

Indigo King. (Morse.)*

Good ; hooded, sinuses at the sides ; large ; good substance ; color, claret, wings purple ; bloom medium-profuse.

Height Aug. 6, six feet, three inches.

† Much like Mad. Carnot ; color not so uniform ; sinuses more constant and pronounced. Finer flower than Madame Carnot.

Isa Eckford. (Morse.)*

Poor ; expanded, notched ; medium size ; poor substance ; color, white flushed with pink ; bloom medium.

Height Aug. 6, five feet, three inches.

Isa Eckford. (Hutchins.)*

Same as Isa Eckford (Morse.)

Johanna Theresa. (Breck.)

Is Light Blue and Purple.

Juanita. (Morse.)

Very good ; expanded ; large ; good substance ; color, white streaked and shaded with pinkish lavender ; bloom medium-profuse.

Height Aug. 6, four feet, three inches.

A poor white intermixed.

† Only good ; lacks character.

Katherine Tracy. (Ferry.)

Very good ; expanded, notched ; medium size ; good substance ; color, shaded pink , bloom medium.

Height Aug. 6, four feet.

† Large size ; poor bloomer ; prettiest blush-pink in patch.

Katherine Tracy. (S. S. & P. Co.)

Like Katherine Tracy (Ferry.)

† Somewhat better than above; deeper in tint, and a better bloomer.

Lady Beaconsfield. (Morse.)* 1894.

Fair; expanded, notched; medium size; poor-fair substance; color, primrose, slightly flushed with purple-rose, wings lavender; bloom sparse-medium.

Height Aug. 6, five feet.

Lady Beaconsfield. (Hutchins.)* 1894.

Same as Lady Beaconsfield (Morse.)

Lady Beaconsfield. (S. S. & P. Co.)* 1894.

Like Lady Beaconsfield (Morse.)

Lady Penzance. (Morse)* 1894.

Good; expanded, variously curled; medium size; fair substance; color, rose-pink with a slightly orange tint; bloom medium.

Height Aug. 6, five feet, three inches.

Stems tend to bend.

Lady Penzance. (S. S. & P. Co.)* 1894.

Same as Lady Penzance (Morse.)

Lemon Queen. (Morse.)* 1892.

Very good; expanded, notched; large; fair substance; color, white delicately shaded with purple-rose more or less suffused; bloom sparse-medium.

Height Aug. 6, five feet, three inches.

† Medium size; looks like Alice Eckford.

Light Blue and Purple. (Morse.)

Poor; reflexed; medium size; very poor substance; color, claret somewhat blotched, wings reddish purple; bloom sparse-medium.

Height Aug. 6, five feet, nine inches.

† Same as Black, except that the wings are a shade or so darker purple.

Little Dorritt. (Breck.)* 1896.

Aug. 3, has not budded.

† No bloom up to Sept. 9.

Lottie Eckford. (Morse.)*

Very good; hooded; large; fair-good substance; color, white edged and lightly shaded with lavender; bloom profuse.

Height Aug. 6, five feet, three inches.

New Lottie Eckford is the only Lottie Eckford now on the market.

† Excellent and distinct.

Lottie Eckford. (S. S. & P. Co.)*

Like Lottle Eckford (Morse.)

Lottie Eckford Improved. (Hutchins.)

Same as Lottie Eckford (Morse.)

Captain Clarke intermingled.

Madame Carnot. (Hutchins.)

Fair; hooded, sometimes with sinuses at the sides; medium size; fair substance; color, rose-mauve, wings purple; bloom profuse.

Height Aug. 6, six feet, six inches.

† Poor, even for a purple. The poorest sweet pea color; not so good as Indigo King, which might be Mad. C. improved.

Madame Carnot. (Burpee.)

Same as Madame Carnot (Hutchins.)

Senator intermingled.

Meteor. (Morse.)* 1895.

Good; reflexed or expanded; medium size; poor substance; color, orange-pink, wings soft rose pink; bloom sparse-medium.

Height Aug. 6, four feet, eight inches.

† Only medium in quality.

Meteor. (S. S. & P. Co.)* 1895.

Same as Meteor (Morse.)

Height Aug. 6, three feet.

Mikado. (Breck.)* 1896.

Seed did not germinate.

Miss Hunt. (Morse.)*

Fair; expanded; medium size; poor; fair substance; color, rose pink; bloom medium-profuse.

Height Aug. 6, four feet, six inches.

Monarch. (Morse.)*

Good; somewhat hooded; large; substance medium-good; color, claret wings purple; bloom sparse-medium.

Height Aug. 6, four feet, six inches.

Mrs. Eckford. (Morse.)* 1892.

Very good; expanded; large; good substance; color, primrose; bloom medium.

Height Aug. 6, four feet, nine inches.

† Finest of the yellow whites.

Mrs. Eckford. (Hutchins.)* 1892.

Same as Mrs. Eckford (Morse.)

Waverly intermingled.

Mrs. Eckford. (S. S. & P. Co.)* 1892.

Same as Mrs. Eckford (Morse.)

Height Aug. 6, three feet.

Aug. 4, one bloom.

*Mrs. Gladstone.**

Good; expanded; medium size; fair substance; color, white flushed and shaded with purple pink; bloom sparse-medium.

Height Aug. 6, four feet.

† Large size; poor bloomer; pink.

Mrs. Joseph Chamberlain. (Hutchins.)* 1895.

Very good; hooded; large; good substance; color, striped purplish ros on white ground; bloom sparse-medium.

Height Aug. 6, four feet, three inches.

† Bloom better toward close of season, but then only medium. Lightest of the striped reds. (See note under America.)

Mrs. Joseph Chamberlain. (S. S. & P. Co.)* 1895.

Aug. 4, not in bloom.

Height Aug. 6, one foot, six inches,

† Did not bloom.

Mrs. Sankey. (Morse.)*

Good ; hooded ; medium-large size ; good substance ; color, white lightly shaded with purplish pink ; bloom sparse-medium.

Height Aug. 6, five feet.

† Poor bloomer.

Nellie Jaynes. (Hutchins.)

Is Painted Lady.

New Sunset. (S. S. & P. Co.)

Aug. 3, not yet budded.

Height Aug. 6, three feet.

† Did not bloom.

Novelty. (Hutchins.)* 1895.

Fair ; expanded, notched ; medium-large size ; poor substance ; color, orange pink, wings rose pink ; bloom medium.

Height Aug. 6, four feet, three inches.

† Poor.

Oddity. (Morse.)

Very good ; hooded ; large ; good substance ; color, light rose pink ; bloom profuse,

Height Aug. 6, four feet, three inches.

† Ground color, "light rose pink" with more or less conspicuous veining of deeper pink. Poor towards close of season.

Orange Prince. (Morse.)*

Fair ; erect, expanded ; small ; fair substance : color, orange-pink, wings, rose pink.

Height Aug. 6, four feet.

Aug. 3, in bud.

Aug. 6, five blossoms.

† Very poor bloomer.

Ovid. (Morse.)* 1894.

Good ; expanded ; large ; fair-good substance ; color, rose pink ; bloom sparse.

Height Aug. 6, four feet, six inches.

† Very poor bloomer.

Ovid. (S. S. & P. Co.)* 1894.

Same as Ovid (Morse.)

Height Aug. 6, three feet.

Painted Lady. (Morse.)

Poor ; reflexed, notched ; medium size ; very poor substance ; color, crimson and rose, wings rose purple, blotched more or less with white ; bloom medium.

Height Aug. 6, four feet, nine inches.

Lemon Queen intermingled.

Peach Blossom. (Hutchins.)* 1894.

Good ; expanded ; medium size ; fair substance ; color, white shaded with purplish rose ; bloom medium.

Height Aug. 6, four feet, three inches.

Said to be hard to grow, but that the difficulty may be overcome by planting thin.

† Only medium in merit.

Peach Blossom. (S. S. & P. Co.)* 1894.

No bloom Aug. 4.

Height Aug. 6, three feet, nine inches.

Primrose. (Morse.)*

Fair ; expanded, notched ; medium size ; fair substance ; color primrose yellow ; bloom medium.

Height Aug. 6, four feet, three inches.

† Medium but constant bloomer.

Primrose. (Hutchins.)*

Same as Primrose (Morse.)

Princess Beatrice. (Morse.)

Good ; expanded ; medium-large size; ; good substance ; color, shaded pink ; bloom medium.

Height Aug. 6, five feet.

Princess Beatrice. (S. S. & P. Co.)

Same as Princess Beatrice (Morse), except that the bloom is sparse.

Height Aug. 6, four feet, three inches.

Princess Louise. (Morse.)

Is Violet Queen.

Princess May. (Hutchins.)

Good ; hooded ; medium size ; good substance ; color, pink lavender ; bloom sparse.

Height Aug. 6, four feet, three inches.

† Very poor bloomer.

Princess Victoria. (Morse.)*

Good ; expanded, notched ; medium-large size ; fair substance ; color, light crimson, wings purple rose ; bloom sparse.

Height Aug. 6, four feet, six inches.

† Closely resembles Blanche Ferry.

Princess Victoria. (Hutchins.)*

Like Princess Victoria (Morse), except that the substance is not so good.

Princess of Wales. (Morse.)*

Good ; expanded ; large ; fair substance ; color, striped red mauve ; bloom, medium.

Height Aug. 6, four feet, six inchcs.

† Very good for a striped flower. Looks like Black and Brown Striped; unattractive.

Purple Brown Striped. (Morse.)

Poor ; reflexed, sometimes notched ; medium size ; poor substance ; color, striped red mauve, wings striped purple ; bloom sparse-medium.

Height Aug. 6, four feet, three inches.

† Large; same as Black and Brown Striped, except that this is a little better bloomer; either this, or the seed is mixed. Flowers in two patches exactly correspond.

Purple Prince. (Morse.)*

Fair; expanded; large; poor-fair substance; color red mauve, wings purple; bloom sparse-medium.

Height Aug. 6, four feet six inches.

The Queen. (Hutchins.)*

Poor; reflexed; medium size; poor substance; color, light rose pink blotched, wings purple pink; bloom very sparse.

Height Aug. 6, three feet nine inches.

† Very poor all round.

Improved Queen. (Morse.)

Mixed Lemon Queen and Senator.

Queen of England. (Morse.)*

Fair; expanded, notched, sometimes with sinuses; medium size; fair substance; color white; bloom sparse.

Height Aug. 6, three feet nine inches.

† Blooms better toward close of season; medium; looks like Emily Henderson, but is a much better bloomer.

Queen of the Isles. (Morse.)*

Fair; reflexed, notched; medium size; poor substance; color, rose crimson striped on white ground, wings striped magenta; bloom medium-profuse.

Height Aug. 6, four feet, nine inches.

† Looks like Red and White Striped.

Queen of the Isles. (S. S. & P. Co.)*

Same as Queen of the Isles (Morse.)

Ramona (Morse.)

Very good; somewhat hooded; large; good substance; color daintily splashed rose purple on white ground; bloom medium.

Height Aug. 6, four feet, three inches.

Red and White Striped. (Breck.)

Poor; reflexed, notched; medium size; poor-fair substance; color, striped rose crimson, wings striped magenta; bloom sparse-medium.

Height Aug. 6, four feet, six inches.

Is Scarlet Striped.

Rising Sun.

Poor; reflexed, notched, wings at a large angle; medium size; poor-fair substance; color, light pink shaded to orange rose at center, wings rose purple; bloom medium.

Height Aug. 6, four feet, nine inches.

† Poor bloomer.

Royal Robe. (Hutchins.)* 1894.

Very good ; expanded ; large ; good substance ; color pink ; bloom very sparse.

Height Aug. 6, four feet, three inches.

Aug. 3, in bud.

† Bloom sparse ; sizè and substance medium.

Royal Robe. (S. S. & P. Co.)* 1894.

Same as Royal Robe (Hutchins.)

† Not so good a sample as Royal Robe (Hutchins.)

Scarlet Invincible. (Hutchins.)

Fair ; reflexed ; medium-large size ; poor substance ; color, bright crimson rose ; wings rose-purple ; bloom sparse.

Height Aug. 6, five feet.

† Closely resembles Blanche Ferry, but darker, if anything.

Senator. (Morse.)*

Very good ; expanded ; large substance ; color, striped red purple ; bloom sparse.

Height Aug. 6, five feet.

† Same as Black and Brown Striped in appearance, but is a poorer bloomer.

Senator. (S. S. & P. Co.)*

Same as Senator (Morse.)

Height Aug. 6, four feet.

Senator, double. (Burpee.)

Very good ; expanded ; large size ; good-fair substance ; color, striped purple ; bloom sparse.

Height Aug. 6, five feet.

† Poor bloomer ; a few doubles.

Splendid Lilac. (Morse.)

Poor ; reflexed, notched, wings at a large angle ; medium size ; poor substance ; color, shaded carmine, wings lavender ; bloom profuse.

Height Aug. 6, four feet, nine inches.

Splendor. (Morse.)*

Very good ; hooded ; large ; good substance ; color, rose-pink ; bloom profuse.

Height Aug. 6, five feet, three inches.

† Occasional doubles ; very poor bloomer at close of season. It is a "cropper."

Splendor. (Hutchins.)*

Same as Splendor (Morse.)

Splendor. (S. S. & P. Co.)*

Same as Splendor (Morse.)

Height Aug. 6, two feet, four inches.

Splendor, double. (Burpee.)

Very good ; hooded ; large ; good substance ; color, rose-pink ; bloom sparse.

Height Aug. 6, five feet, three inches.

Doubled somewhat ; mixed with Butterfly.

Stanley. (Morse.)* 1894.

Good ; expanded ; large ; fair substance ; color, dark rich rose maroon ; bloom medium-profuse.

Height Aug. 6, five feet.

† Looks like Boreatton.

Stanley. (Hutchins.)* 1894.

Same as Stanley (Morse.)

Etna intermingled.

Stanley. (S. S. & P. Co.)* 1894.

Same as Stanley (Morse.)

Venus. (Morse.)* 1893.

Very good ; hooded ; large ; fair-good substance ; color, white lightly flushed with pink-purple ; bloom sparse.

Height Aug. 6, three feet, nine inches.

Venus. (S. S. & P. Co.)* 1893.

Same as Venus (Morse.)

Vesuvius. (Morse.)

Poor ; reflexed, wings at large angle ; poor substance ; color, light purple shaded toward center ; wings rose-purple ; bloom medium-profuse.

Height Aug. 6, four feet, six inches.

† Small and poor.

Violet Queen. (Hutchins.)*

Poor ; reflexed ; medium size ; poor-fair substance ; color, white shaded with carmine, wings pink-lavender ; bloom medium.

Height Aug. 6, four feet, six inches.

† Size and substance poor.

Waverly. (Morse.)* 1892.

Very good ; somewhat hooded ; large ; good substance ; color, rose-claret, wings purple ; bloom medium.

Height Aug. 6, four feet, six inches.

† Very handsome for a purple ; the best of its color ; compares very favorably with Duke of Clarence ; room for both in purples.

Waverly. (Hutchins.)* 1892.

Same as Waverly (Morse.)

White Double. (Burpee.)

Fair ; hooded, sinused ; medium size ; fair-good substance ; color white ; bloom very sparse.

Height Aug. 6, three feet, nine inches.

Did not double.

† Very poor bloomer.

III. NUMERICAL NOTES ON THE SWEET PEAS.

(*M. G. Kains.*)

The sweet pea is always attractive. In all its varied forms and tints it is the same dainty charmer. There is no ugly sweet pea. It is, therefore, perhaps unfortunate that the words "poor" and "medium" are used; and that dates and figures, which have always an air of business, range themselves against such innocent victims. But in all variety studies some standard has to be adopted and even the sweet pea must submit. In estimating the attributes of a variety the popular scale of ten is used. A composite ideal is formed by choosing one variety as a standard of size, another of substance, and so on; then comparing the variety to be judged with this norm.

In the following table the name of the variety, and, in parentheses, the name of the grower are given. Then follow the date of first bloom, the season at which each variety was at its best on our grounds—early, medium or late—and the date of the last bloom. There were a few isolated blossoms after October 10, but the frosts of the eighth and ninth had reaped their harvest and the blooming season was past. After the date column, follow the height in feet, the length of stems in inches; then, on the scale of ten, the estimates on general productiveness of bloom and of seed, on relative size, and substance of flower.

In a collection of ten varieties the following might be chosen:

Blushing Beauty,
Apple Blossom,
Countess of Radnor, or Dorothy Tennant (substitute),
Duke of Clarence, or Waverly (substitute),
Boreatton,
Eliza Eckford, or Katherine Tracy if it were a better bloomer,
Mrs. Eckford,
Ramona,
Gray Friar,

and for a white either Queen of England or Alba Magnifica. Neither of these whites is equal in merit to those in the above list, but none of the whites are. These two have the least number of bad points.

Name.	1st Bloom.	Season.	Last Bloom.	Height, ft.	Length of stems, in.	Quantity of Bloom.	Production of seed.	Size.	Substance.
Adonis (Morse)	July 15	M.-L.	Oct. 10	7	7	8	3	5	4
Adonis (Hutchins)	July 10	M.-L.	Oct. 10	6	6	7	6	5	4
Alba Magnifica (Morse)	July 10	E.-L.	Oct. 10	6	3	8	6	6	6
Alba Magnifica (Hutchins)	July 10	E.-L.	Oct. 10	6	5	7	9	7	6
Alice Eckford (Breck)	July 18	Mid.	Oct. 10	5	7	5	5	8	6
America (Morse)	July 13	E.-M.	Oct. 10	6	6	9	7	7	4
American Belle (Breck)	July 10	Mid.	Oct. 10	7	6	7	7	10	9
Apple Blossom (Morse)	July 10	Mid.	Oct. 10	6	4	4	6	10	9
Apple Blossom Double (Burpee)	July 10	Mid.	Oct. 10	6	8	8	6	9	9
Black (Morse)	July 12	M-L.	Oct. 10	7	9	9	2	5	4
Black and Brown Striped (Breck)	July 12	E.-M.	Sept. 5	6	7	8	6	6	6
Black Purple (Breck)	July 9	M.-L,	Sept. 5	6	9	8	3	5	4
Blanche Burpee (Morse)	July 15	Mid.	Sept. 5	3	3	7	4	6	4
Blanche Burpee (Hutchins)	July 11	Mid.	Sept. 5	5	5	7	3	8	6
Blanche Ferry (Morse)	June 30	Earliest	Sept. 5	6	4	7	9	6	6
Blushing Beauty (Morse)	July 14	Mid.	Oct. 10	5	7	7	4	9	8
Blushing Bride (Breck)	July 1	Early	Sept. 12	6	9	7	4	7	6
Boreatton (Morse)	July 13	Late	Oct. 10	5	8	8	4	6	3
Boreatton (Hutchins)	July 13	Late	Oct. 10	6	8	8	4	6	3
Boreatton Double (Burpee)	July 30	Late	Oct. 10	5	7	6	7	7	6
The Bride (Lynch)	July 14	Mid.	Oct. 10	5	5	6	4	8	7
Bronze King (Morse)	July 12	Mid.	Oct. 10	6	3	4	3	5	5
Butterfly (Morse)	July 9	Mid.	Oct. 10	5	6	6	5	8	7
Butterfly (Burpee)	July 14	Mid.	Oct. 10	5	8	7	6	7	7
Butterfly Improved (Morse)	July 14	Mid.	Sept. 28	7	4	7	8	7	7
Butterfly Winged (Morse)	July 14	Mid.	Sept. 28	6	9	10	6	9	9
Captain Sharkey (Breck)	July 9	Mid.	Oct. 10	6	2	7	5	4	6
Captain Clark (Morse)	July 8	Early	Oct. 10	6	9	8	5	4	5
Captain Clark (Hutchins)	July 8	Early	Oct. 10	5	3	8	4	4	5
Captain of the Blues (Morse)	July 12	Mid.	Oct. 10	5	3	4	2	7	7
Captivation (Breck)	July 29	Late	Oct. 10	4	9	4	7	7	7
Cardinal (Morse)	June 30	Early	Sept. 12	8	8	10	8	6	4
Carmen Sylva (Hutchins)	July 15	Mid.	Oct. 10	7	4	7	6	4	5
Carmine Invincible (Morse)	July 10	Mid.	Oct. 10	6	6	8	5	6	5
Countess of Aberdeen (Breck)	——	——	——	5	——	——	——	——	——
Countess of Radnor (Morse)	July 13	Mid.	Oct. 10	7	8	9	4	10	9
Countess of Radnor Improved (Morse)	July 14	Mid.	Oct. 10	7	6	4	2	10	9
Crown Jewell (Breck)	Aug. 31	Late	Oct. 10	4	——	——	——	2	2
Crown Princess of Prussia (Morse)	July 15	Mid.	Oct. 10	6	4	5	2	3	3

Name.	1st Bloom.	Season.	Last Bloom.	Height, ft.	Length of stems, in.	Quantity of bloom.	Production of seed.	Size.	Substance.
Daybreak (Morse)	July 13	Mid.	Oct. 10	4	4	3	2	5	4
Daybreak (Hutchins)	July 11	Mid.	Oct. 10	6	5	5	4	5	4
Delight (Morse)	July 13	Mid.	Oct. 10	7	4	6	4	3	4
Dorothy Tennant (Morse)	July 12	M.-L.	Oct. 10	6	6	4	3	9	8
Duchess of Edinburgh (Morse)	July 12	Mid.	Sept. 22	7	3	7	4	5	4
Duchess of York (Morse)	July 22	Mid.	Sept. 22	4	3	4	4	7	6
Duke of Clarence)Morse)	July 16	Mid.	Oct. 10	5	7	6	5	8	7
Duke of Clarence, Double (Burpee)	July 15	Mid.	Oct. 5	6	6	4	5	9	8
Duke of York (Morse)	July 17	Mid.	Sept. 22	6	6	6	5	6	5
Duke of York (Morse)	July 16	Mid.	Sept. 22	7	7	9	6	6	5
Eliza Eckford (Hutchins)	July 15	Mid.	Oct. 10	7	8	9	5	9	8
Emily Eckford (Morse)	July 16	Mid.	Oct. 10	7	5	3	3	9	9
Emily Henderson (Morse)	July 11	Mid.	Sept. 22	6	9	8	7	6	6
Emily Henderson (Hutchins)	July 22	Mid.	Sept. 22	4	4	3	3	6	6
Empress of India (Morse)	July 16	Early	Sept. 22	8	4	6	6	6	6
Etna (Hutchins)	July 13	Mid.	Oct. 10	6	4	6	5	5	4
Fairy Queen (Morse)	July 10	Mid.	Oct. 10	6	4	7	3	6	5
Firefly (Morse)	July 18	Mid.	Sept. 12	6	8	8	4	7	6
Firefly (Hutchins)	July 14	Mid.	Sept. 12	7	7	8	3	7	6
Firefly, Hooded (Morse)	July 14	Mid.	Oct. 10	6	7	6	3	10	6
Gaiety (Morse)	July 14	Mid.	Oct. 10	6	4	6	6	7	5
Gray Friar (Morse)	July 1	Early	Sept. 12	6	9	6	8	9	6
Harvard (Breck)	July 5	Early	Sept. 22	7	6	8	8	6	5
Her Majesty (Morse)	July 10	Mid.	Sept. 22	6	7	8	8	9	8
Ignea (Morse)	July 16	Mid.	Oct. 10	7	6	6	7	6	5
Imperial Blue (Morse)	July 8	E.-L.	Oct. 5	8	6	8	8	6	5
InvincibleBlue (Hutchins)	July 14	Mid.	Oct. 5	8	6	8	9	6	6
Invincible Black (Hutchins)	July 16	Mid.	Sept. 22	7	7	9	9	8	6
Invincible Carmine (Hutchins)	July 11	Mid.	Sept. 22	7	7	9	8	7	4
Invincible Scarlet (Breck)	July 1	Early	Sept. 12	6	6	7	5	7	4
Indigo King (Morse)	July 10	Early	Sept. 22	6	7	8	6	7	7
Isa Eckford (Morse)	July 16	Mid.	Oct. 5	7	7	7	6	6	4
Isa Eckford (Hutchins)	July 12	Mid.	Oct. 5	5	7	6	5	6	4
Johanna Theresa (Breck)	July 3	Early	Sept. 22	6	6	8	6	6	3
Juanita (Morse)	July 15	Mid.	Sept. 22	4	7	8	5	8	8
Katherine Tracy (Ferry)	July 16	Mid.	Sept. 22	5	5	4	4	8	8
LadyBeaconsfield (Morse)	July 18	Late	Oct. 10	6	7	7	4	6	6
LadyBeaconsfield (Hutchins)	July 14	Late	Oct. 10	7	8	7	4	6	6
Lady Penzance (Morse)	July 15	Mid.	Oct. 5	6	6	8	5	7	6
Light Blue and Purple (Morse)	July 12	Mid.	Oct. 5	6	5	7	7	6	3
Lemon Queen (Morse)	July 16	M.-L.	Oct. 10	6	7	8	5	6	6
Little Dorritt (Breck)	—	—	—	4	—	—	—	—	—
Lottie Eckford (Morse)	July 20	Late	Oct. 10	6	6	7	8	9	7

Name.	1st Bloom.	Season.	Last Bloom.	Height, ft.	Length of stems, in.	Quantity of bloom.	Production of seed.	Size.	Substance.
Lottie Eckford (Hutchins)	July 16	Late	Oct. 10	5	8	7	9	9	7
Madame Carnot (Hutchins)	July 12	Mid.	Oct. 5	6	5	9	8	6	5
Madame Carnot (Burpee)	July 12	Mid.	Oct. 5	8	7	10	8	6	5
Meteor (Morse)	July 15	Mid.	Sept. 22	7	6	9	5	5	3
Miss Hunt (Morse)	July 14	Mid.	Oct. 10	5	6	7	6	6	6
Monarch (Morse)	July 17	Late	Oct. 10	5	7	8	6	10	7
Mrs. Eckford (Morse)	July 15	E.-L.	Oct. 10	6	9	9	4	10	9
Mrs. Eckford (Hutchins)	July 14	Early	Oct. 5	6	8	8	5	10	7
Mrs. Gladstone (Morse)	July 17	Mid.	Oct. 5	6	9	8	6	8	8
Mrs. Jos. Chamberlain (Hutchins)	July 16	Late	Oct. 10	5	8	8	6	9	8
Mrs. Sankey (Morse)	July 22	Late	Sept. 22	6	5	4	3	7	7
Nellie Jaynes (Hutchins)	July 1	Early	Sept. 28	7	4	9	10	6	6
New Sunset (S.S.&P.Co.)	——	——	——	5	—	—	—	—	—
Novelty (Hutchins)	July 16	Mid.	Sept. 28	5	7	9	5	6	4
Oddity (Morse)	July 16	Early	Sept. 12	4	9	8	6	7	8
Orange Prince (Morse)	July 21	Late	Oct. 5	4	7	5	4	5	5
Ovid (Morse)	July 16	Mid.	Sept. 28	5	6	4	4	7	6
Painted Lady (Morse)	July 16	Early	Oct. 5	4	6	8	5	6	6
Peach Blossom (Hutchins)	July 15	Mid.	Sept. 28	6	8	8	6	6	6
Primrose (Morse)	July 16	Mid.	Oct. 10	5	5	8	4	6	6
Primrose (Hutchins)	July 16	Mid.	Oct. 10	5	5	7	5	6	6
Princess Beatrice (Morse)	July 12	Early	Sept. 22	6	5	8	5	6	6
Princess Louise (Morse)	July 14	Mid.	Sept. 22	6	5	7	4	4	2
Princess May (Hutchins)	July 14	Mid.	Oct. 10	5	8	4	6	6	5
Princess Victoria (Morse)	July 12	Early	Sept. 22	5	6	7	5	7	6
Princess Victoria (Hutchins)	July 15	Early	Sept. 22	6	6	6	5	7	5
Princess of Wales (Morse)	July 14	E.-M.	Sept. 12	5	6	8	5	9	7
Purple Brown Striped (Morse)	July 14	E.-M.	Sept. 12	4	6	7	7	9	7
Purple Prince (Morse)	July 17	Mid.	Sept. 28	6	7	7	6	7	7
The Queen (Hutchins)	July 16	Mid.	Oct. 10	5	6	6	4	5	5
Improved Queen (Morse)	July 22	Late	Oct. 10	6	8	4	1	—	—
Queen of England (Morse)	July 17	Mid.	Oct. 10	4	5	8	4	6	6
Queen of the Isles (Morse)	July 15	Mid.	Sept. 22	5	7	8	4	7	5
Ramona (Morse)	July 16	Mid.	Oct. 10	4	6	6	4	10	8
Red and White Striped (Breck)	July 16	Mid.	Oct. 10	4	6	7	6	6	6
Rising Sun (Morse)	July 10	Early	Sept. 12	5	5	6	7	6	6
Royal Robe (Hutchins)	July 21	Late	Oct. 10	6	5	6	5	5	5
Scarlet Invincible (Hutchins)	July 16	Mid.	Oct. 10	6	7	7	5	6	4
Senator (Morse)	July 21	Late	Oct. 10	6	6	6	4	10	9
Senator, Double (Burpee)	Aug 20	Late	Oct. 10	6	8	1	0	9	7
Splendid Lilac (Morse)	July 11	Early	Sept. 22	6	7	8	7	6	4
Splendor (Morse)	July 10	Early	Oct. 5	6	8	9	6	9	7
Splendor (Hutchins)	July 11	Early	Oct. 5	6	6	8	7	9	7
Splendor, Double (Burpee)	July 30	Late	Oct. 10	6	6	5	4	9	7
Stanley (Morse)	July 14	E.-L.	Oct. 10	7	9	10	5	8	4

Name.	1st Bloom.	Season.	Last Bloom.	Height, ft.	Length of stems, in.	Quantity of bloom.	Production of seed.	Size.	Substance.
Stanley (Hutchins)	July 14	E.-L.	Oct. 10	7	9	10	6	8	4
Venus (Morse)..........	July 16	Mid.	Oct. 10	6	8	6	3	8	7
Vesuvius (Morse)	July 13	Early	Sept. 12	5	6	7	4	4	4
Violet Queen (Hutchins)	July 17	Mid.	Sept. 28	6	4	7	5	4	2
Waverly (Morse)........	July 20	Mid.	Oct. 10	6	6	6	6	10	7
Waverly (Hutchins)	July 10	Mid.	Oct. 10	7	7	8	6	10	7
Double White (Burpee)..	July 15	Mid.	Oct. 10	4	7	6	7	6	5

Bulletin 128. February, 1897.
Cornell University Agricultural Experiment Station,
ITHACA, N. Y.
HORTICULTURAL DIVISION.

A TALK ABOUT

DAHLIAS.

By WILHELM MILLER.

PUBLISHED BY THE UNIVERSITY,
ITHACA, N. Y.
1897.

ORGANIZATION.

BOARD OF CONTROL:

THE TRUSTEES OF THE UNIVERSITY.

STATION COUNCIL.

President, JACOB GOULD SCHURMAN.

Hon. A. D. WHITE,	Trustee of the University.
Hon. B. F. TRACY,	President State Agricultural Society.
Professor I. P. ROBERTS,	Agriculture.
Professor G. C. CALDWELL,	Chemistry.
Professor JAMES LAW,	Veterinary Science.
Professor J. H. COMSTOCK,	Entomology.
Professor L. H. BAILEY,	Horticulture.
Professor H. H. WING,	Dairy Husbandry.
Professor G. F. ATKINSON,	Botany.

OFFICERS OF THE STATION.

I. P. ROBERTS,	Director.
E. L. WILLIAMS,	Treasurer.
E. A. BUTLER,	Clerk.

ASSISTANTS.

M. V. SLINGERLAND,	Entomology.
G. W. CAVANAUGH,	Chemistry.
L. A. CLINTON,	Agriculture.
B. M. DUGGAR,	Cryptogamic Botany.

Office of the Director, 20 Morrill Hall.
The regular bulletins of the Station are sent free to all who request them.

BULLETINS OF 1897.

124. The Pistol-Case-Bearer in western New York.
125. A Disease of Currant Canes.
126. The Currant-Stem Girdler and The Raspberry-Cane Maggot.
127. A Second Account of Sweet Peas.
128. A Talk about Dahlias.

CORNELL UNIVERSITY, Ithaca, N. Y., Feb. 22, 1897.

HONORABLE COMMISSIONER OF AGRICULTURE, ALBANY.

Sir:—When I came to New York, now several years ago, I was interested in the dahlias which are to be seen in so many of the farm-yards. To me, coming from a newer country, the dahlia was mostly a thing of the books. At least, I had no personal interest in it, for wherever I had seen the plant growing, it had been planted in a merely incidental way as a part of some confused and impersonal garden. But in the country districts of New York it clings to the old yards like a memory; and I knew that here the plant is a survival of the dahlia passion which overspread the country a generation and more ago. If the people loved this old flower so much as to cherish it in all these years of its unpopularity and neglect, I thought that we ought to improve it and refine it and let them grow it to their heart's content. So I have looked forward to the time when I might give a summer to it, but the summers are now too full to allow of such recreation. But an opportunity finally offered. The new strains of dahlias began to be advertized. Persons interested in the cultivation of it offered to coöperate in furnishing tubers, and I found the man who could catch the spirit of the experiment. I submit the result as a bulletin under Chapter 437 of the laws of 1896.

Although Mr. Miller may not agree, I do not consider the dahlia to be the chief merit of this bulletin. The best thing in it is the personal point of view. Flower-loving is sentiment and emotion, kindled with imagination. It depends vastly more upon the person than it does upon the flower. Some persons would like to love flowers but they do not know how; and there are others who think that they love them because they know their names and how to grow them. But I suspect that no one ever really loves a flower when he is conscious of an effort to love it. When a person once places himself in full sympathy with nature and learns the art of seeing everything at its best, he is in position to reap the joy of a garden; and it really does not matter so very

much whether the plants are dahlias, sweet peas or bull-thistles.

I am convinced that the farmers need education in flowers and other incidental things quite as much as they do in wheat or potatoes, for it is the lack of cheer and color and interest about the home which is largely responsible for the dissatisfaction of the young people with the country. The moment that a farmer begins to take a living interest in some restful occupation for his leisure hours will his interest in farm life begin to grow. Now and then, therefore, we like to drop a bulletin upon his table which will come as a solace and stimulant to his leisure hours, awakening memories and opening strange lines of thought. We cannot tell him directly how to get the most comfort from the gentler things of the farm, but we can take a familiar object for a narrative and a lesson; and if the dahlia has such an established place at the farmstead, it will be a good text for our purpose.

Aside from our desire to extend flower-loving and nature-study to the country, we are under obligations to the flower-trade, which is a most valued constituent and supporter of the experiment stations. I may say that members of the trade may obtain a sketch of the varieties we grew last year by writing us for it.

A curious incident of our dahlia studies occurred in connection with the American Institute Fair in New York, at which we made an exhibit of over 200 varieties. A florists' paper said that "the only commendable feature of this stand was the great number of kinds staged." Another horticultural journal said that it was "a very extensive collection of dahlias, but the blooms were not of exhibition quality." We had not supposed that such misconception of the office of an experiment station exists amongst the makers of public opinion. Surely it is no part of the business of a station to grow plants for mere exhibition. The growers themselves can do that, and they can usually do it much better than the experiment station can. The station's mission is to simply lay the truth before the people. It can have no favorites in varieties. If it exhibits at all, it is bound to show the poor and indifferent kinds along with the good ones. It is just as useful to point out defects as it is to point out merits. In studies of varieties, the experiment station is a realist. In our dahlia patch, all the varieties were given good soil and

good care, but nothing more; and when we showed them at Philadelphia and New York we took the varieties as they run, good and poor alike. If the varieties were not satisfactory, it is easy to see where the fault lies; and there is therefore all the more need for an experiment to show the actual status of the business. We have found, as the result of considerable experimentation in various lines of floriculture, that we do not often get the best stock which the dealers have. We often receive the tag-ends. If the dealers are willing that the varieties should be judged by such plants, we have no reason to object. It is of course, perfectly natural and proper that the originator of new varieties, or the exhibition grower, should retain his best strains for his own use, and for this reason the experiment station can never hope to equal the specialists in the quality of plants, even if such were its legitimate ambition.

We made our dahlia exhibitions upon the express understanding that the flowers were not entered for competition, and they were designed—as we supposed every one would know—as an illustrative and educational display of the kinds in the market, of the range in forms and colors and other features which the flowers possess, and of what the grower may expect of the plant; and we desired to collect information for our own use. The officers of the Institute evidently caught the spirit of the exhibition, for, unknown to us, they awarded the Experiment Station a bronze medal and a diploma for "a display of 212 varieties of typical dahlias."

All these remarks are made, not as a defense, but simply to illustrate by a concrete example what an experiment station is for. Its purpose is to make records. It would clearly exceed its province if it were to grow plants primarily for "exhibition quality," and the florists would no doubt be amongst the first to object to such competition.

L. H. BAILEY.

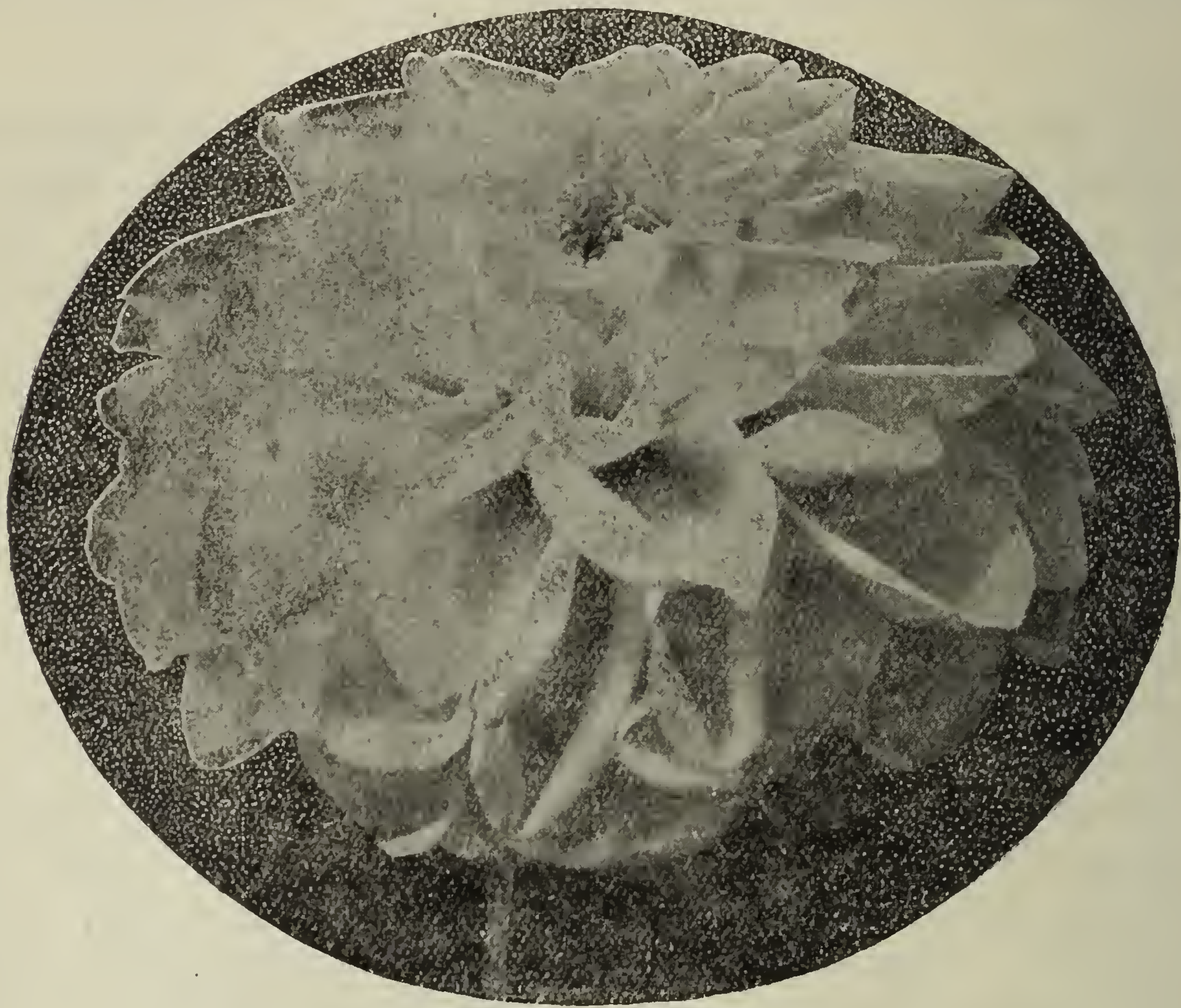
24.—*Mrs. A. Peart.* A white cactus dahlia.

A TALK ABOUT DAHLIAS.

To very many people it will be news and scarcely credible news that dahlias have any freedom and grace of form, or any delicacy and modesty of color. The prejudice against them may never again be as strong as it is now. They are associated with a period of formalism which found its expression in highly artificial camellias, and in carnations from which the fringes,—their natural beauty—had been painfully removed by a long process of plant-breeding. The era of hoop-skirts was the time of the dahlia furore; and what a tyrant the dahlia was! It is still remembered as a flower the size of a croquet ball, almost as hard in outline, and with colors sometimes equally coarse and gaudy. How are the mighty fallen! The reaction against formal flowers carried the popular enthusiasm towards the loose, free, and fantastic Japanese chrysanthemums. Perhaps the deserted idol felt that the populace had gone off to strange gods. But I like to think that the poor dahlias breathed a sigh of relief when their convent days were over. They revelled in their neglect. It was bad enough to have their natural inclinations snubbed and suppressed. But it was very hard, after a period of success, to be accused of inherent primness and stiffness when those qualities were merely the result of their rigid system of education. The fault was not with the dahlias, but with the single standard of beauty that was in the minds of men. As a matter of fact the dahlia is probably able to express itself in as many wonderful and indescribable forms as the chrysanthemum is. But the dahlia has not had the chance. Chrysanthemums have been in cultivation, it is said, for over two thousand years. The double forms of the dahlia are less than a century old, and the so-called "cactus dahlias" which are going to save the whole race by their freedom and informality practically date from 1879, when the first cactus dahlia was exhibited and pictured in England. We already have many forms (Figs.

24, 32) which are surprisingly like some of the chrysanthemums, but the evolution of the dahlia is only just begun.

A brief history of the dahlia.—The first dahlias seen in Europe grew in the Botanical Gardens at Madrid in 1789. The seeds were sent from Mexico. The flowers were very much like that of Fig.



25.—*Miss May Lomas.* A large-flowered variety.

27, *i. e.* they had eight rays disposed in a single circle around the yellow disc. In 1814, the first double forms were produced at Louvain, Holland, after three years' work. All members of the composite family that have been through the process of doubling and have enough flexibility to entitle them to extended cultivation exhibit at least three strongly marked tendencies. One tendency is to reproduce the single forms (Fig. 27). This habit can be easily fixed and flowers of this type are called single varieties. Another tendency is toward the production of very large globular flowers that are completely double, as in Fig. 25. These large-flowering varieties are the hardest to produce and the hardest to maintain. They are always prized most highly because

the element of human skill is very large. A third tendency is toward what are called pompons. These are dwarf plants with spherical and double flowers like the last but much smaller and much more abundant. The single varieties are the most natural; the large-flowering and pompon varieties are in a larger measure the products of art. The dahlia was held pretty rigorously to these old and familiar lines of development, and unfortunately these somewhat conventional and artificial forms are still popularly supposed to be essential to the nature of the dahlia. The first double forms came to England in the winter of 1814, and in 1826 there were already sixty varieties cultivated by the Royal Horticultural Society. In 1841 one English dealer had over twelve hundred varieties.

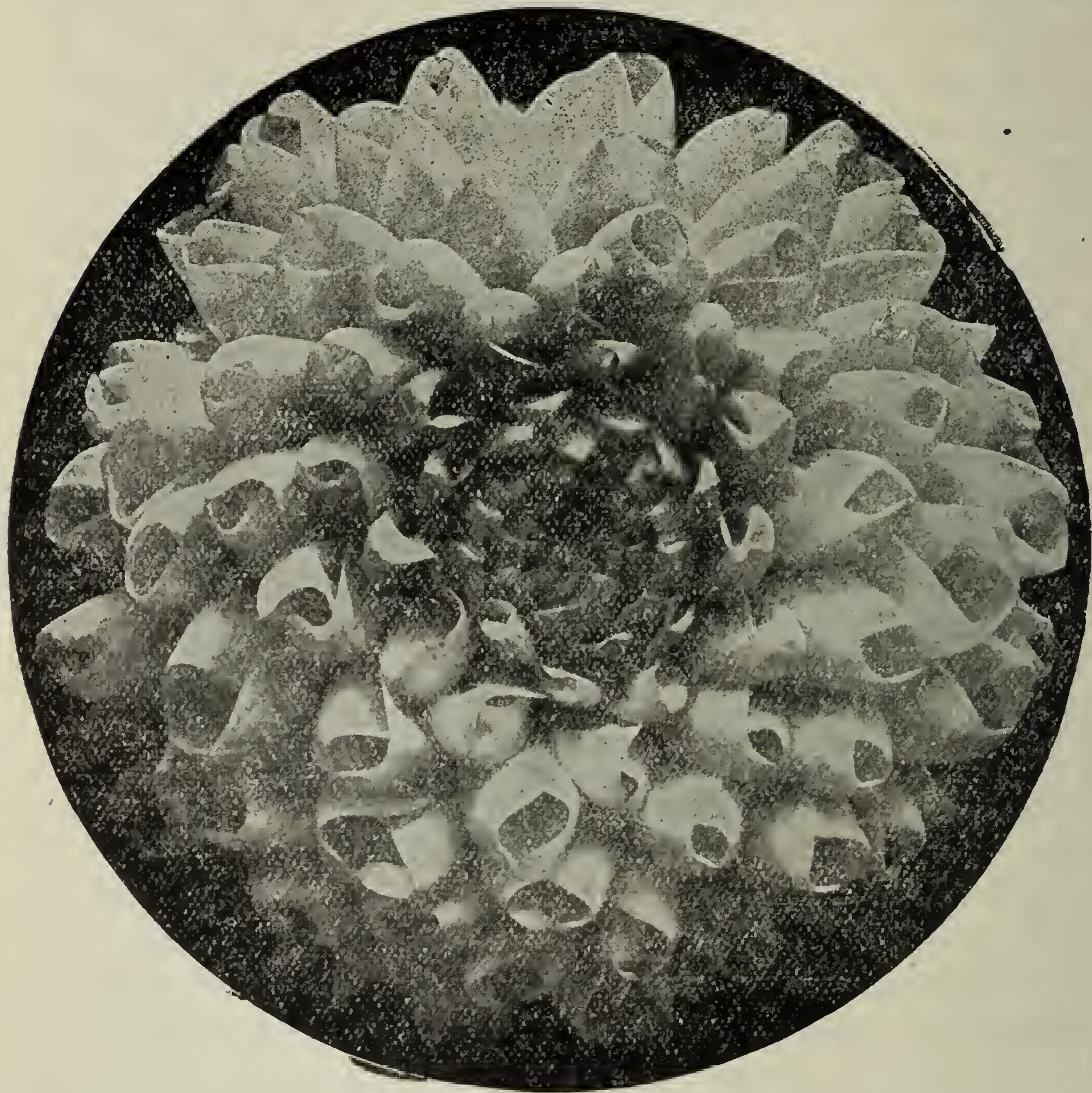
This is a wonderful variation for a plant that had been in cultivation practically only twenty-seven years. Many other species have been in cultivation for more than a quarter of a century before showing any signs of "breaking the type" *i. e.* making a pronounced variation from their wild form. It also gives some hint of the extraordinary range of color, for the dahlia was permitted to display its color charms in but three forms, the single, the pompon or small sphere, and the big sphere of the large-flowering varieties.

In the forties and fifties variegated flowers were in great demand. Dahlias were striped, banded, speckled, penciled, dotted, blotched, and marked in all sorts of curious ways. There was as much ingenuity in the invention of these unstable compounds as is now displayed in designs for wall paper and oil cloths. These things were catalogued under the "Fancy" class, for the English divide the large-flowering varieties into "Show" and "Fancy." The "Show" section contains the "selfs," that is those varieties each of which has but a single color. The varieties of popular flowers that have unity of color-effect are usually longest lived; those having mixed color-effects are usually more unstable and are dropped out of cultivation when the popular enthusiasm goes elsewhere.

In the evolution of the dahlia too much attention has been paid to color and not enough to form. Those twelve hundred varieties of 1841 were too much like twelve hundred variously painted balls

of two sizes. How much better would it be to have thirty pure, distinct, single colors in forty different forms of expression!

There was not a single new or original idea in the evolution of the dahlia until 1873 at the very earliest, and whatever freedom or grace the dahlias now have is traceable to a single plant that



26.—*Grand Duke Alexis.* A large dahlia of peculiar form.

bloomed for the first time that year. Instead of short, stiff, artificially formed rays, this flower had long, loose, flat rays with pointed or twisted ends and the peculiar red that is associated with cacti. This variety was named *Juarezii*, in honor of Juarez, President of Mexico, and first offered for sale in 1874 by a Dutch merchant. This was the parent of the so-called cactus dahlias, a name which seems far-fetched now-a-days. It was the color

and not the form that gave the point to the comparison in the first place, and we now have a very great variety of colors in that form—colors that do not necessarily remind one of cacti. The white variety *Mrs. A. Peart* (Fig. 24), has a form very similar to that of the brilliant red cactus dahlia pictured in 1879. The The cactus type has been kept quite pure, and of late years it has also been modified into some of the loose and flowing forms of the Japanese chrysanthemums. The cactus dahlias have also been crossed with specimens of the old ball type, and there have resulted such new forms as that of *Wm. Agnew* (Fig. 30), which may be taken as one type of a class that is sometimes called the semi-cactus. Whether the variety *Miss May Lomas* (Fig. 25), has any of the cactus blood in it (I had almost written *ichor*, for I believe it is an element of immortal youth), I cannot say. The rays are still short, and show the creases of the old strait-jacket, but on the whole, the outlines are considerably relaxed and softened. It would be puzzling to explain off-hand how such a form as that of *Grand Duke Alexis* (Fig. 26) may have arisen. This may look somewhat curious and mathematical in print, but in the living flower it has a peculiar charm and grace. I should like to see a whole set of dahlias of this form through the whole range of colors. In this case, there is no chrysanthemum that I know of quite like it. We have not attained as yet such freedom of form as is expressed in the tangled mass of golden threads known as the chrysanthemum *Mrs. W. H. Rand*, nor the serpentine grace in the long slender, writhing petals of *Medusa*.

The rays only have been developed in the case of the dahlia and the disc-flowers entirely neglected. The bewildering variety of forms in the chrysanthemums have their origin in two elements, the ray and the disc-flower. The chrysanthemum *Northern Lights* is composed entirely of very long slender tubes which are arranged in a loose, whorled fashion (see Bulletin 112, Fig. 94). It will be many years doubtless before the short, yellow disc-flowers of the single dahlia can be drawn out to so great a length. But it can be done, and there is no reason in the nature of things why we should not have a race of dahlias analogous to the anemone-flowered chrysanthemums, one of which, *Mrs. F. Gordon Dexter*, is figured on the title page of Bulletin 91. These effects

can certainly be produced, and it is probably only a question of time when we shall have all the shapes of the chrysanthemums.

Why and how dahlias should be changed.—Perhaps some one may ask, "Why do you wish to change the nature of the dahlia? If you are satisfied with the rose as such, and the lily, and would not try to make either like the other, why do you want to make dahlias look like chyrsanthemums?"

The big round dahlia of the old school is not nature,—it is art. Or, at best it is only one type of beauty. Dahlias are not essentially big and round. It is their nature to vary into many forms. Of the forms that nature gives us, we select the ones we like and destroy the rest. There are at least two good reasons why the chrysanthemum-like forms would be desirable in dahlias ; first, because the foliage is different, and flowers are entitled to different settings of foliage, just as precious stones may have their beauty set off in various ways. The foliage of the new cactus types is often distinctly graceful and beautiful. This, too, is good news for those who could not tell a field of dahlias from a field of potatoes at a moderate distance. Secondly, the growing of chrysanthemums in this climate is a highly specialized industry requiring greenhouses, capital and skill. Dahlias can be grown outdoors by everybody. Anyone can have them in his garden, and have lots of flowers, and at much less cost. It is a mistake to suppose that the best dahlias can be raised without skill and trouble. But while chrysanthemums will not tolerate ignorance or neglect, dahlias give an astonishing return for a minimum of work. Moreover the seasons are quite different. The first frost will always kill the dahlias out-of-doors while the chrysanthemums are preparing their November glories within.

These chrysanthemum-like forms are some of the best and most numerous that we have, and we cannot have too much of informal grace and beauty. We ought to have these types all the year round. The China-asters have many of these forms, as well as others not preserved among chrysanthemums and not yet achieved by dahlias, in a different set of colors, and at an intermediate season. They too have their place. These three genera, Chrysanthemum, Dahlia, Callistephus are not competitors, but friends that supplement one another, and of all the composites in

cultivation, they are by far the most promising and the most productive of new forms. They all have the same kind of materials to work with—ray and disc-flowers—and they are by nature fitted to express the same kinds of beauty. The rose and the lily have two other very different kinds of natural endowments and two very different types of beauty, not superior or antagonistic, but different.

The title-page of this bulletin illustrates a kind of beauty that is not usually associated with the dahlia. The gentleman who ordered this variety from Holland thought himself badly cheated because the flowers were small and only semi-double. It is true that semi-double forms often lack character, but sometimes they have prettiness and individuality, though they never get any prizes at the exhibitions.

The peculiar merits of the dahlia.—Meanwhile, what are some of the present advantages the dahlias possess? As to foliage, they have at least five times as much variety as the chrysanthemums do. They have the old familiar potato-like foliage, which is naturally rather broad and coarse. Much of this rankness, however, is due to methods of cultivation. Secondly, there is the new cactus type which is graceful and delicate enough to attract attention of itself. Between these two extremes there are many intermediate forms which the eye recognizes, but whose lines of beauty can scarcely be suggested by descriptions. Speaking only of very distinct forms, we have a very finely cut type of foliage of which *Fern-Leaved Beauty* is perhaps the best at present. Then there is still another type of foliage whose form is not so noticeable as its rich, dark red color. *Ami Barillet* has these dark reddish leaves with a single flower of cardinal. We had only one other variety of this type last year. Its single yellow flowers did not seem to go so well with this reddish foliage and perhaps some other colors may prove to be quite inharmonious with it. Here is a hint for one line of evolution for the dahlia. This reddish color is very uniform, and I am entirely convinced that it has a natural look and is not merely a curiosity. To me it looks much more at home in the garden than the purple beeches do on the streets. Finally, there is a tendency towards variegation in the dahlia leaf which seems to me fully as legitimate as the

whitened leaf-edges of many ornamental shrubs. It has appeared more than once in the history of the dahlia, and seems to be unstable and difficult to preserve. It is worth trying to keep, for at the least, it is attractive, and very agreeable for a change. The foliage of dahlias is undeniably monotonous, and a garden needs these lively touches now and then, not only to set off the genuine beauty of the more delicate forms, but also to lighten the general effect of the whole mass.

Coming now to the flowers, the old ball type is a capital form in itself, just the thing to display strong single colors, dazzling scarlet, vivid reds, big soft snowballs of white—a cool and pleasant handful—masterful yellows, rich golden yellow and truly regal purples. The form itself I have no quarrel with except that the rays are often too short and stiff and artificially folded. But I do protest against having only one ideal of beauty, just as we are advised to beware of the man of one book. A bed of old fashioned dahlias insolently interrupting the quiet restfulness of a green-sward with its loud, clashing colors, ought to be an audible protest against the man with one idea of beauty. Mere size alone in flowers is always vulgar. It is no wonder that the big dahlias are never seen in the windows of the New York florists. At the corner flower stands these huge things begin the day as big and hard as mallets. By night they have subsided into a soggy mournfulness. Women could no more wear them than a purple cabbage.

The show varieties indeed are chiefly designed for the exhibition-hall where great size is particularly admired; this is especially true of Europe, where dahlia-shows are still in high favor. It is impossible not to like some of these, but the garden is the place where they can be enjoyed most. They are a glorious sight in the sunlight, but they are inclined to look artificial indoors, and their colors are often changed or extinguished when brought into the house.

The pompons, however, are suitable for cut flowers, and their artificiality is attractive, quaint, or comical. They are like richly dressed children; their faces are very clean, and bright, and their tailor-made clothes are prim and neat or quaint and odd. Their formality is often pretty and amusing, as of those that imitate their elders. *Little Arthur*, *Little Bessie*, *Little Bobby*, *Little Charlie*,

Little Rifleman, *Little Valentine* and *Little Wag* are names of some pompons and there are many testimonies to their child-like grace and beauty. These pompons have been brought to a high degree of perfection. Their evolution is practically complete. They have a beauty and a place of their own, and no one would wish them any different. As a class, they offer the cheapest method I know of for producing great quantities of flowers two inches in diameter. A variety that does not have from ten to sixty flowers at a time from the 4th of July until the September or October frost is not worth keeping. They are the very thing for small yards and for certain city conditions, especially where people are likely to steal flowers. Anyone who enjoys giving away flowers should have some pompons. They grow up quickly and hide bare, ugly places and are the ideal for those people who delight in having things trim, neat and tidy. The peculiar merits of the pompon dahlias, then, are their profusion, their wide range of color, and their cheapness.

27.—*A single dahlia*

The single dahlias (Fig. 27) will probably be enjoyed as long as the star-like beauty of the daisies and marguerites is appreciated. They, too, are quite perfect in their way, and they are largely for quantity. Of late years the plants have been made dwarf and compact. There is now a whole race called "Tom Thumb Single Dahlias." I hate to talk about "improving"

flowers. It has a bad sound. To many people it is well-nigh sacrilegious to talk of "improving nature." Strictly speaking, we cannot create; we can only select from the forms that nature gives us, and keep what we like. Whoever declares that wild flowers are intrinsically more beautiful than cultivated ones, and insists on having dahlias just as they are in nature, must move

28.—*Viridiflora*. The green dahlia.

to Mexico, and will then find that the forms are not stereotyped. Nature can print "dahlia" in as many kinds of type as our best publishing houses can. Dahlias grow wild in Mexico in sandy places, at five or seven thousand feet above the sea level, know nothing of frost, and are used to a long dry season. They do vary wonderfully in Mexico and they are bound to vary even more so in New York. The dwarfing of dahlias is a perfectly legitimate hing. Nature does it, and we have a perfect right to prefer some

of her forms to others. I hate to see dahlias tied to stakes. The compact bushy plants that never grow more than two feet high have their flowers massed and make a single picture. The tall, ungainly, sprawling varieties have too much foliage in proportion to the number of flowers. There is no unity of effect. The flowers are scattered, and the attention is distracted. And the stakes are unsightly and troublesome. These dwarf dahlias, therefore, are just the thing for flower-beds and borders and wherever masses of color are wanted in small compass. The taller single varieties have been extravagantly overvalued in their day. They have even excelled the show varieties in popular favor for a time. Vilmorin still catalogues one hundred and eleven single varieties.

The peculiar merits of the cactus dahlias have been mentioned. Figures 26 and 30 are only two of many forms quite peculiar to the dahlia. The dahlia is not without its curiosities, such as sporting varieties, like *Beauty Inconstant* which bears pure white or pure yellow flowers, or pinkish ones, or red ones "freaked" with any of these colors, and *Viridiflora* the so-called "green dahlia" (Fig. 28), which is a monstrosity similar to the green rose. The range of color is even greater than that of the Japanese chrysanthemums, being particularly rich in dark reds and strong, clear shades of purple. The dahlia *A. D. Livoni* exactly matches the pink of Mr. Mathews's color chart and I am very sure that the chrysanthemums do not have it at all. Whether they can ever reach it through the color that Mr. Mathews calls crimson-pink is doubtful. Dahlias are also very rich in iridescent effects, *Ruby Queen*, *Oban*, and *Mrs. W. H. Maule* being good examples. The texture of flowers is a point wasted on people who do not love a garden. Dahlias are sometimes waxy, sometimes loose and fluffy, and a loving gardener loves to feel and handle them.

The place for dahlias is the garden.—They never can have a place in landscape gardening because the first frost kills them. I often think their strength is dissipated when they are strung along a walk or other border. Personally, I believe in flower beds, but not in the middle of a beautiful green lawn. The grass has a quiet story to tell, and if dahlias intrude they should be put out for disturbing the peace. I wish I could have a whole bulle-

tin in which to tell the fun of gardening. It cannot be enjoyed by proxy. I enjoy especially those gardens that have one theme, one central feature, no matter what are the modifications. A collection of roses, of sweet peas, of China asters, or of anything, has a certain unity, which, however, need not exclude minor features and miscellaneous favorites. Dahlias are the hobby of the Rev. C. W. Bolton, of Pelham, near New York City. His house is a picture by itself and one would never suspect what treasures are in his back-yard. Mr. Bolton is an early riser, and takes rest and solid comfort in his garden. He has the pompons nearest to his house, for they are the boys and girls and he catches them playing games. There are cool grass walks between the double rows of big dahlias. Mr. Bolton is rich in dahlias and he has been their friend in need. Many a beautiful dahlia has he saved from oblivion. He loves color, and this is a beautiful and easy way to get it. It is a cheap way of painting. No one can expect to raise such beautiful, large-flowering dahlias, unless he takes trouble, and no one is entitled to success who does not like to nurse plants and watch the flowers daily. Mr. Bolton's garden has been a good and cheap doctor. The pompons snuggle up against the gray walls of the church and make a warm and cheery picture.

29.—*Rev. C. W. Bolton, who connects the old-time dahlia furore with the returning passion.*

Dahlias should be in a place by themselves. Possibly a dahlia can be used now and then "as an exclamation point," a flash of color to lighten up other foliage near a house or wherever a cheerful look is desired. The herbaceous border is no place for dahlias. Indeed the big ball type of flowers is rarely furnished

by the composites amongst perennial herbs. Blue-bells and columbines are typical inhabitants of the herbaceous border and their beauty is of a different sort from the big solid ball-like dahlias.

Dahlias as cut flowers.—While sweet peas can be picked indiscriminately and put in a single vase, dahlias have such a wide range of color that the flowers must be carefully sorted. This adds to the fun of arranging, and gives time to look at each one separately. A vase full of a single variety gives a strong and pure effect. It is a great mistake to jumble all sorts and colors of flowers into the same jar. The European and American ideas on this subject are entirely opposed. The German idea of a bouquet is too often a cluttered lot of miscellaneous flowers all huddled together without regard to conflicting colors and different types of beauty. Dahlias go well with nothing else. They keep fairly well for about three days, and take up great quantities of water through their succulent stems. Dahlia-shows can never be as popular in America as they are in Europe, until there is a greater variety in their forms. While the garden is the true exhibition place for dahlias, where one may revel and riot in their color, the dahlia-show is not to be discouraged. The large-flowering dahlias are just as worthy of separate notice as so many paintings. They are, in a sense, works of art and deserve to be studied individually. It is, therefore, a mistake to crowd them together in a bad light. Gas light particularly, deadens and falsifies the colors of flowers.

A few words on color.—I made the experiment of describing all the varieties this year by the aid of color charts. Kohn's color chart was given a fair trial but proved unsatisfactory. The color chart of F. Schuyler Mathews was very handy and helpful, although Mr. Mathews employs names which may be used by artists but will never be used by the flower trade. There were two fine single varieties which were among the very first to bloom and had flowers every day until the end of the season. One of these matched the scarlet of Mr. Mathews's chart perfectly, and the other was as near cardinal as petal and pigment can ever be. These two varieties then became the standard for all near shades of red. The same variety is often described in one catalogue as scarlet and in another as crimson ; yet Mr. Mathews says there are fifty easily recognizable shades between them. The standards

for color must be within the dahlia itself, but the standards must first be chosen by some outside aid. If the American Dahlia Society would register all dahlias, and give each one an official description, using a cheap and sensible color-chart as a guide, people could have some idea of what they are buying. *Penelope* is described by Dreer as white, tipped with purple ; by Pierson as white, delicately tinted magenta ; by Rawson as pure white with violet tips, and by Peacock as pure white, delicately flaked with lavender. This illustrates the difficulty of determining a secondary color of which a small amount is present. By crowding together the petals with the hand the secondary color comes out more strongly. *Miss May Lomas* and *La France* (Maule's) belong to this same class. Their beauty lies in these delicate secondary tints which are all of purple origin and can never be fixed. Dilute purple sufficiently and you get what Mr. Mathews calls crimson-pink. This crimson-pink has two bad faults : it is inclined to be laid on unevenly in patches and veins instead of being evenly suffused, and it is so variable in quantity and quality as to make it a lottery what sort of a flower one is to get. There is only one pink dahlia I know of (for *A. D. Livoni* and *Ethel Vick* seem to be identical) that shows no trace of a purple or crimson origin. I shall not have a particle of faith in the stability of any other dahlia advertised as pink until I see it. *Mrs. Gladstone* is a very much praised variety and at Ithaca in 1896 it had a very beautiful and uniformly suffused light pink. I expected to recommend it as among the very best, and should surely have done so if I had not seen flowers from two other localities which betrayed the origin of this pink. They showed two different degrees of a hateful purple and I should never have supposed them to be the same thing. Whenever the words "lavender" "rosy-pink" or "violet" appear in descriptions of dahlias one may feel almost certain that they refer to this treacherous crimson-pink. Sometimes these tints are pretty well fixed, *e.g.* the lavender in *Arabella*.

The variety commonly known as *Mme. Moreau* would pass for for a pink until brought side by side with *A. D. Livoni*, when the purplish cast of the former is evident. In "selfs" *i.e.* flowers having but a single color, these shades are practically fixed and uniform, but variegated dahlias containing degrees of purple,

crimson, rose, magenta, violet, lavender and pink can never be relied upon from descriptions. They may be any one of these shades for they depend upon factors in cultivation which are little understood and perhaps uncontrollable. Pure and delicate shades of pink can never be reached by such means. Plant-food may deepen them all the way to purple in a single season and they are almost sure to revert to purple ancestors sooner or later.

Variegated flowers as a class.—Mixed color-effects can rarely compete for strength and brilliancy with singly colored flowers, and they are very unstable. "Selfs" have a unity of effect; their color is single, strong, undivided. Variegated flowers are distracting, and artificial, and remind one of the constant straining after effect. *W. C. Denzel* is one of the very few dahlias in which two colors are combined to give a soft and delicate single effect. If there is such a thing as a modest dahlia, this is surely one. It is distressing not to be able to recommend such a variety on a year's trial. Next year these same tints may deepen into a purple and a yellow that will conflict with each other. We have altogether too many variegated dahlias and not enough variety in form. They are essentially the most unstable, and the first to suffer from a popular reaction. These fanciful creations can never be permanently popular. The number of people who delight in formal flowers is certainly much greater proportionately in Europe than in America, and this leads me to make a plea for an American evolution of the dahlia. The forcing-house carnation is an American product. Carnations are grown mostly outdoors in Europe in beds and borders. They have short stems and a sudden rush of bloom in summer, and then all is over until another year. They are painted and penciled and marked in all sorts of ways foreign to our taste. Picotees can never have the permanent prosperity in America that they do in England; Americans want long-stemmed carnations the year round. We should never have had midwinter carnations at twenty-five cents a dozen if we had stuck to the old European lines of evolution.

The need of live colors.—It often happens that dahlias which are full of glowing color in the sunlight are very tame and subdued in the shade. Mr. Peacock the dahlia specialist of Atco, N. J.,

has done some intelligent crossing to produce live colors. The story of the variety *Wm. Agnew* (Fig. 30) is an interesting one. Mr. Peacock noticed that most of the reds he knew had no life out of the sunlight. He began with a large ball-shaped dahlia named *Crimson Giant* the great size of whose flowers he coveted. The

30.—*Wm. Agnew*. A fine scarlet orange semi-cactus variety.

pollen of this variety was used on *Professor Baldwin*, which is said to have been a sport from the original cactus dahlia. It had a scarlet orange flower, and Mr. Peacock had noticed that a touch of orange lightens up flowers wonderfully in the shade. This was a violent cross as the parents were as far apart in form as are figures 24 and 25. In the seedling the flower had the cactus-like

form of the female parent and the color of the male parent was modified to a deep scarlet. However, the flower faded badly. This seedling was now crossed with *Cochineal*, a ball-shaped flower of rich unfading dark red. *Cochineal's* only defect was an open center of yellow, and the flowers were only medium-sized. The rich dark red of *Cochineal* did not prevail in the cross, but the fading habit was eliminated in the product which is called *Wm. Agnew* (Fig. 30). The flowers are uniformly very large, of semicactus type, and of a fine intense scarlet orange color. The trace of orange thus subtly infused into the flower makes it a lively color in sun or shade. This variety was no earlier than the cactus sorts at Ithaca last year, but Mr. Peacock says it is a month earlier than the rest. This unexpected trait he cannot account for, but it is one of the greatest importance as the cactus sorts are often a month behind the old school dahlias in their blooming time.

Suggestions for plant-breeders.—1. The lengthening of the season of the dahlia is one of the most striking examples of its plasticity in cultivation. When dahlias were first introduced they bloomed for barely a week or two before frost. Now, they ought to be in bloom by the fourth of July and some of them at least can be made to blossom continously from June 15th. The cactus varieties were on the average a month later than the rest at Ithaca, in 1896, and their season needs lengthening.

2. The ugly stakes must go. Already we have a race of single and pompon varieties that need no stakes to support them. Four feet is high enough for any dahlia plant. The cactus varieties particularly are inclined to be too tall and straggling.

3. While dwarfing in general is desirable, there is one kind of it that seems to me mistaken. *Triomphe de Solferino* is typical of a class used for bedding. It has huge flowers, coarse and flattish, and out of all proportion to the amount of foliage. I enjoy looking at cabbages,—in a cabbage plantation. I see no beauty in abnormally large flowers on abnormally dwarf plants. Here again nature gives the hint. The tendency to pompons means that a large number of small flowers is more in harmony with a compact plant than a few very large ones. I believe that extreme dwarfing of show varieties is mistaken craft and false art. The

variety named after Rev. C. W. Bolton is typical of a race of plants to be used for bedding which ought to be developed in America. *Triomphe de Solferino* has a thick stem which cuts like timber. One has to cut down nearly the whole plant and trim off the coarse, clumsy foliage in order to get two or three flowers, which are, after all, only vegetable curiosities and will not go into a vase. *Rev. C. W. Bolton* has a multitude of medium-sized flowers on long, slender stems just right for cutting. Three big flowers on a little plant distract the attention as would individual squashes, or pumpkins. Pompons have a unity of effect in their multitude of detail; and midget and lilliputian are prettier words than humpbacked dwarf.

31.—*Rev. C. W. Bolton.* Flower naturally four inches in diameter.

4. The cactus varieties often have a trick of hiding their flowers under the leaves. This is no great calamity in the case of old fashioned bedders like *Triomphe de Solferino*. Here *Rev. C. W. Bolton* (Fig. 31) is again the type and the ideal, its many slender stems raising the flowers above the foliage.

5. The whorled effect in *Priscilla*, *Blumenfalter* and others, must be pretty and novel to those who know only the old-time dahlias. Their so-called quilled rays are arranged in a circular or rotary fashion which gives a certain neatness and mock-military precision that is often pretty and attractive, particularly in young flowers, as in children playing soldiers.

6. In the march toward chrysanthemum-forms, the long, flat and slender rays will be of most help to get the free, loose, and fluffy types. Fimbriated forms, like *Guiding Star*, are desirable in themselves and may also aid in introducing irregularity. The rays of the old show dahlias are too short and stiff. Ragged, untidy and intermediate forms have possibilities.

7. We need more prizes for new forms and less effort to increase the range of color. Let the China-asters have the shades of blue. That is their mission. In *Gardeners' Chronicle*, 1879, John Keynes is quoted as saying: "The first good Dahlia I ever raised was Ovid, the seedling root of which I sold to Mountjoy for £50. I think we have never seen a nearer approach to a blue Dahlia." I have seen colored plates of varieties supposed to be on the way to blue. They were mostly shades of purple. I do not believe that an azure blue can ever be attained through either purple or lavender. Beware of crimson-pink.

8. We have as yet no forms like the tubular or Japanese anemone-flowered chrysanthemums nor many of the forms of China-asters illustrated in Bulletin 90. Apparently no attempt has been made to lengthen out the disc-florets into long, slender tubes.

9. *Princess Harry* and others may have the possibilities of a race similarly to the hairy chrysanthemums. The tendency towards hairiness appeared in England and was patiently suppressed before 1888 when the chrysanthemum craze was started in America by the purchase of the hairy variety *Mrs. Alpheus Hardy* for $1500.

10. In addition to the five types of foliage already described (p. 109), there is sometimes a peculiar glossiness on the leaves which may perhaps be turned to account.

11. Dahlias are sometimes slightly fragrant, and at least one skillful plant-breeder is now at work along this line. Perhaps a few curiosities of this sort may be obtained, but the lack of fragrance is probably a natural limitation. Dahlias have glories enough without fragrance.

12. The buds often open with difficulty and make lop-sided flowers. Chrysanthemums sometimes have this difficulty and the same misfortune has been known to occur in other com-

posites growing wild. The dahlia, however, is notorious for producing many imperfectly blown flowers. Some think it is one of the limitations of the dahlia and must be endured. Others think that it has not been in cultivation long enough. Some varieties are nearly free from this trouble, but I do not know whether it is a matter of variety or cultivation.

The cultivation for dahlias.—In sandy soils dahlias make comparatively few tuberous roots, tend to become dwarf, and flower profusely. In very rich loamy soils they make more roots and fewer flowers. Too much nitrogenous food makes a rank, coarse growth and few flowers. No amount of added plant-food can ever atone for neglect of the physical condition of the soil. Mr. Peacock is able to have fifteen acres of dahlias in continuous bloom throughout a long summer of drought. Imagine this brilliant spectacle after nine weeks without a rain ! And yet, dahlias are very sensitive to lack of moisture. While it is true that Mr. Peacock is an expert cultivator and devotes all his time to dahlias, yet like all skillful managers of the highest type, he has no professional secrets. The whole story is one of conservation of moisture already in the soil. Moisture is constantly rising by capillary action and its evaporation must be prevented. Frequent shallow cultivations break off the capillary tubes and prevent this escape of moisture into the air. This earth-mulch is obtained in the garden by lightly stirring the two or three inches of surface soil with a hoe or rake. Below that depth the soil should be constantly moist, not wet, throughout the whole growing season.

The large-flowering varieties need a space of four feet square to bring them to perfection as individual plants. The best results are gotten from planting them in rows so that they may be thoroughly cultivated. These rows should be at least five feet wide if a horse is to be driven through frequently.

There are three systems of training dahlias, that deserve notice. First, a policy of non-interference which allows as many shoots to come up from the roots as may. This is the proper way to grow most of the varieties catalogued as pompons, dwarfs, and bedders. In the large-flowering and cactus kinds, where fewer and more perfect flowers are desired, this method will not do, because the shoots compete with each other and exhaust the

vitality of the plant in producing foliage instead of flowers. The second method might be called the main trunk system. Only one shoot is allowed to grow from a clump of roots, all the other shoots being pinched off. This method, therefore, produces a tree-like growth, instead of a bushy form like the first. However, this system, which is the old-fashioned one, requires stakes and tying, for such plants will droop and split and are badly broken by high winds.

The third method is the "single stem branching system" which is successfully practiced by Mr. Lawrence K. Peacock and described in his book, "The Dahlia," at page 24. It is a most ingenious device for doing away with the unsightly stakes, and has many incidental advantages. All the shoots but one are removed, and this one is allowed to grow until two pairs of leaves are above ground with a young and unexpanded growth on the top. This undeveloped portion is pinched off, and four young buds which are lurking in the axils of the two pairs of opposite leaves are very much rejoiced. Some or all of them will now grow out into long branches. Let us suppose that all four of them grow equally. The plant will then have a very short, thick and strong single stem which comes up only an inch or two above ground and then gives place to four long branches. These branches are strong enough to hold themselves up without stakes and they can endure heavy winds. Indeed, a still greater division of labor is desirable, and each of these growing branches should have its terminal growth pinched out at the same early stage already indicated, *viz.*, when only two pairs of leaves are fully developed. Practically, however, plants do not grow in this mathematical way, for one of the two buds waiting for a chance, usually gets the start of his fellow and soon outclasses him. The practical thing to do is to keep the plants from making a main trunk. The object is to have the plants branch at the surface of the ground, and the pinching must be done as early in the season as possible. It is a common belief among gardeners that late pinching makes short-stemmed flowers, and early pinching gives the long stems so much desired. This system therefore, means work and watchfulness, but it causes less trouble than staking and tying.

It is best not to take up the dahlia roots for at least a week

after frost, as the tubers ripen better and are not so likely to shrivel when stored in the cellar over winter. The roots should be turned upside down in the sunshine to let the water drain out of the stems.

Cut flowers of dahlias can be shipped for at least three hundred miles if they are carefully packed in boxes six inches deep. They are sure to spoil if more than one layer deep. Moss must be used about the stems and the bunches should be small and securely wrapped with oil paper They demand a great deal of room for long distance shipments. For short distances, they can be more compactly and easily handled.

A good word about frost.—The first freeze is sure to kill the dahlias, but frosts can be prevented. A freeze is a disturbance over a large area, and is usually associated with winds. A frost is a local affair, and comes on cloudless nights when no air is stirring. Frost is due to the quick radiation from the earth after night-fall. Clouds reflect this warm radiating energy. There are two ways of preventing the heat of the earth from quickly radiating off into space,—making an artificial cloud, and making the atmosphere moister than the soil. A few degrees of frost can be averted by simply sprinkling the plants thoroughly at night-fall. On large plantations it will pay to have a man stay up all night and keep a dense cloud of smoke constantly hanging over the field. This method is used among the vineyardists in parts of France. Neighbors are warned to expect frost by a system of alarm-bells. Foyers, or boxes of tar compounds, are lighted and make a dense smudge. The smell is enough to keep the attendants awake. Any damp rubbish that will burn with a great smoke will do. Some weeks after all the dahlias near Philadelphia were killed by the first frost an enterprising dealer was shipping from eight to ten thousand cut flowers of dahlias to the city every day. He had saved his plants by one night's work. It often happens that there is a light frost in early September and not another sign of frost for three or four weeks after.

The commercial possibilities are very great. It is the next flower to be urged upon the notice of the American public. The machinery of the floral trade is working for it. Quantities of dahlias have been given away by dry-goods stores, and

people are surprised that these new and graceful forms are those of dahlias. We cannot have too many flowers. It is pleasant to have lots to cut and lots to give away. The cactus dahlias are evidently to be the next great commercial success in the floral world. Popular enthusiasm may come and go, but their freedom and grace of form, and brilliant colors entitle them to permanent prosperity.

Origin of the cactus dahlia.—The following is the first description of the cactus dahlia, published in England. It is from the *Gardeners' Chronicle* for Oct. 4, 1879.

"At one of the recent meetings of the Royal Horticultural Society considerable attention was attracted to a remarkable Dahlia, exhibited by Mr. CANNELL under the name of the CACTUS DAHLIA. In the Dahlia as ordinarily seen the florets are rolled up so as to resemble so many short quills open at the ends, but in the present case the florets were all flat or nearly so, strap-shaped like the outer florets of the original species (ray-florets), and of a rich crimson colour. The appearance was, therefore, very striking, and suggestive of a new race in Dahlias analagous in some respects to the Japanese Chrysanthemums."

The following is from the *Gardeners' Chronicle* for Nov. 8, 1879:

"DAHLIA JUAREZII.—When a short time since we figured this remarkable Dahlia from specimens sent us by Mr. CANNELL, we took some pains to ascertain its history, but with little result. Thanks to Mr. Krelage, of Haarlam, and Mr. Jongkindt Coninck, of the Tottenham Nurseries, Dedemsvaart, near Zwolle, we are now enabled to give the history of this Dahlia, as narrated by the introducer, in the Dutch journal *Sempervirens.*

"'When reading the *Gardeners' Chronicle* of October 4, 1879, I was agreeably surprised to see a well-made figure of natural size of an old acquaintance of mine, Dahlia Juarezii. I was still more surprised to see by the few additional lines that very little is known about the origin of this beautiful Dahlia, be it a species or variety. I am, therefore, pleased to avail myself of the opportunity of giving a few details about its origin and history, and to say that I imported it directly from Mexico, and was the first who introduced it to the trade in the Netherlands as well as in other countries. In the autumn of 1872 a friend of mine in

32.—*Matchless.* A velvety maroon cactus dahlia. Half size.

Mexico sent me a small case containing different kinds of seeds, bulbs, and flower-roots from that country. The case was a long time on the road, and, as often happens with private importations, the plants arrived in a very poor condition ; the seeds were mixed, partially germinated, and spoiled ; the bulbs and flower-roots rotten. However, I kept all that was in a tolerable condition, carefully awaiting the result. At last, from a very small flower-root, a tender shoot developed itself, which soon proved to be a Dahlia. It being winter I could only make cuttings of it. Having taken great care of them, I was much pleased to obtain in the spring of 1873 a few young plants of this Dahlia. When planted out in June in the open ground with my other Dahlias, it flowered at the same time as these, and not only surprised me, but all who saw it in bloom, by its large rich crimson flowers, quite different from all other Dahlias. The brilliant red colour of its flowers nearly equaled that of the poppy, and was very showy even at a good distance. My catalogue of 1874, in which year I first introduced that Dahlia to the trade, will prove the truth of my assertions. In that catalogue it is mentioned for the first time under the name of Dahlia Juarezii, which name I gave it in honour of Mr. JUAREZ, then President of Mexico. The fact of Messrs. ANT. ROOZEN & SONS, at Overveen, deriving it from France, is easily understood, when I say that I yearly send to one of the leading French seedsmen a great many Dahlia roots, amongst which were some of Dahlia Juarezii. It is remarkable that the name of Cactus Dahlia should be used in the *Gardeners' Chronicle*, as in my catalogue of 1874, in which I first mentioned it, I said that its flowers when seen at some distance resembled those of Cereus (Cactus) speciosissimus. To maintain the honour of Dutch horticulture, I deem it desirable to write these few lines.—*J. T. Van der Berg, Juxphaas, near Utrecht.*' "

Books, societies and dealers.—There are four books devoted entirely to the dahlia, of which only one is modern. "The Dahlia," by Lawrence K. Peacock, is an illustrated book of fifty-six pages. The books of E. Sayers, Boston, 1839 ; Joseph Paxton, London, 1838, and of Robert Hogg, London, 1853, are out of print and out of date.

The secretary of the American Dahlia Society is Lawrence K.

Peacock, Atco, N. J. The Secretary of the National Dahlia Society of England is T. W. Girdlestone, Sunningdale, Berks.

In order to answer the inquiries of our readers in advance, we give a list of American dealers who catalogue more than twenty-five kinds of dahlias, whose lists have come to our table:

A. Blanc & Co., 314 N. Eleventh St., Philadelphia, Pa.

Henry A. Dreer, 714 Chestnut St., Philadelphia, Pa.

John Gardiner & Co., 631 Market St., Philadelphia, Pa.

Peter Henderson & Co., 35 Cortland St., New York, N. Y.

Wm. Henry Maule, 1711 Filbert St., Philadelphia, Pa.

Samuel C. Moon, Morrisville, Pa.

Wm. H. Moon, Morrisville, Pa.

W. P. Peacock, Dahlia Specialist, Atco, N. J.

F. R. Pierson Co., Tarrytown-on-Hudson, N. Y.

Pitcher & Manda, Short Hills, N. J.

W. W. Rawson & Co., 34 South Market St., Boston, Mass.

John Saul, Washington, D. C.

The Storrs & Harrison Co., Painesville, O.

Vaughan's Seed Store, 84 Randolph St., Chicago, Ills., and 26 Barclay St., New York, N. Y.

James Vick's Sons, Rochester, N. Y.

W. W. Wilmore, Dahlia Specialist, Denver, Col.

The following is a partial list of foreign dealers who catalogue a great many varieties of dahlias:

England.

H. Cannell & Sons, Swanley, Kent.

J. Cheal & Sons, Crawley, Sussex.

Charles Turner, Slough.

Thos. S. Ware, Tottenham, London

Germany.

(Dahlias are commonly called *Georginen* in Germany.)

Max Deegan, Köstritz, Reuss-Thüringen.

Haage & Schmidt, Erfurt.

Carl Kaiser, Nordhausen.

France.

L'Établissement Horticole Bruant à Poitiers (Vienne).
Vilmorin-Andrieux et Cie, 4, Quai de la Mégésserie, Paris.

New Zealand.

D. Hay & Son, Auckland.

The Cornell variety test of 1896.—Three hundred and fifty-four different named varieties were grown at Ithaca last year. There were over a thousand varieties catalogued in 1896 in different parts of the world. Our card-index has over two thousand names already, and no effort has been made to trace the older varieties back to their original descriptions. The Cornell University Library has all of the important horticultural journals and magazines complete, except the earlier volumes of *Gartenflora*. The *Gardeners' Chronicle* has accounts of dahlia-shows and descriptions of varieties from 1841 down to the present time. We should be very glad to receive any old books or catalogues containing descriptions of dahlias. We also desire varieties which are not on our list of varieties tried in 1896. The reader may be interested to know that we shall have growing next summer a good collection of the wild dahlias of Mexico.

Like all garden plants that have been idolized and neglected, the dahlia suffers greatly from having its names of varieties badly mixed. At least thirty-one of the varieties sent us have names that may mean two or more things each. It is also very common to find the same thing under different names. It is enough for present purposes to determine that *A. D. Livoni* and *Ethel Vick* are evidently two names for the same thing, without attempting to trace back the variety to its original description. The determination of synonyms is a work that takes years and implies a large collection of books, considerable expense, and the co-operation of the trade. *Arabella* and *Mrs. Peary* are two varieties that are said to have originated independently, but they are so nearly alike that both would never be desirable in small collections. They are typical of a class that are practically synonymous, but where there is a chance for individual judgment and preference.

The public should be cautioned not to expect the highest results the same year roots or plants are received. The quickest

way to get best results the same season is to order large clumps of roots from trustworthy firms that give prominence to the dahlia in their catalogues. Our dahlias were frequently cultivated and hoed in 1896, but were given no commercial fertilizers, the object being to judge them under ordinary conditions. This year they may be given extraordinary care and judged at their best. Many of the varieties produced no blooms at all in 1896. A. Blanc & Co. sent 79 varieties, containing mostly importations and very recent varieties which were received too late to be fairly compared with the rest. W. W. Wilmore, the dahlia specialist of Denver, Col., sent a large collection which suffered unjustly because it was detained indoors until some tardy shipments arrived which had been promised by a certain date. Henry A. Dreer sent 136 varities, W. P. Peacock 58, and James Vick's Sons 8 varieties.

Of all these varieties there were about sixty that behaved well the first year and which seemed to be quite perfect in their way. I had hoped to say a good word for all of these, but the list has been sadly cut down in several ways. In the first place, there were many names which may mean two or more things. *Dandy* is the name of an English and an American large-flowering variety and also of a pompon. Cannell gives two varieties named *Hector*, one directly following the other. Secondly, we received the same thing under different names. *Maud*, *Marguerite* and *Model of Perfection* produced the same kind of a magenta flower, altogether the best of that color in the large-flowering class. Thirdly, I do not feel safe in recommending any variety with crimson-pink in it, not even the variety commonly known as *Mme. Moreau*. This is a very serious matter and has come up in the chrysanthemum test in a curious form. Some of the very best and purest white flowers we had were described as pink in the catalogues. Fourthly, at least five of the very best sorts which were used as color standards turned out to be not true to name. I should be glad to recommend these varieties if I could be sure of the names. Fifthly, there are certain parts of the color range that seem to be very much over-crowded. Dahlias are singularly rich in purples and dark reds. The competition is so great that there are often a dozen or more kinds with differences minute enough to show different origins but too nearly alike in

general effect to allow all to survive. Some of these are sure to go sooner or later, and the sooner the better. In such cases it is often simply a question of individual preference. In the case of some fifteen pompons where judgment has been suspended, the problem has resolved itself into a mere matter of relative profuseness. The prolific habit is sometimes fixed in the variety, and sometimes varies from year to year according to cultural conditions. This important character cannot be determined in a single year.

Some of the best known varieties are sadly missing from the recommended list, simply because of their behavior in this one locality. It is very trying to keep silent about *Red and Black*, a beautiful banded cactus variety because it was not prolific enough at one place, one year. We must have a high standard, particularly of profuseness. It is also hard to deny myself the pleasure of putting *Clifford W. Bruton* and *Mrs. W. H. Maule* in the recommended list, on the strength of seeing them elsewhere. These varieties were not sent to us. The former is by all odds the purest yellow of any large cactus I know of. The latter has a red flower with a wonderful bluish cast, giving an iridescent effect. Then again, there are many good varieties which are not recommended simply because there are better ones in sight or to be hoped for. *Sternfalter* and *Glare of the Garden* are examples.

I do not believe the general public needs more than three hundred of the two thousand or more varieties now offered by name, but I suppose that there are at least three hundred varieties so pronounced and individual that no one could wish them any different. Let us suppose that there are seven factors that make a variety desirable:

Height—say five degrees, between very dwarf and very tall.
Foliage—at least five types.
Form of flower—say three types, that of D. variabilis, D. Juarezii, and of forms intermediate between these two species.
Doubleness of flower—say only two degrees.
Size of flowers—say only two degrees, large and small.
Color of flowers—say thirty easily recognized colors.
Variegation—say ten styles of marking.

The man with one standard of beauty ought to blush for shame at the suggestion of the combinations made possible by the mul-

tiplication of these factors. But I fear that he has no imagination and cannot see how there may be three hundred or more types of beauty, each of which is true to an ideal and leaves nothing left to wish for. Take it or not, but do not say one is better than another. It is all a matter of individual preference. For these reasons the inevitable question, "What are your twelve best varieties?" is something of a temper-tester. But it is a perfectly fair question if it implies individual preference and disregard of curiosities and varieties for special purposes. It is a very practical one, and here is the answer that I give based on one year's behavior of the plants:

Mrs. A. Peart, cactus, white.
Nymphaea, cactus, pink.
Wm. Agnew, cactus, scarlet orange.
Maid of Kent, cactus, scarlet and white.
Black Prince, cactus, dark red.
Grand Duke Alexis, large flowered, chiefly white.
A. D. Livoni or *Ethel Vick*, large flowered, pink.
Rev. C. W. Bolton, large flowered, variegated, red and yellow.
Fern-Leaved Beauty, large flowered, banded, red and white.
Guiding Star, pompon, white, imbricated.
Vivid, pompon, scarlet orange.
Ami Barillet, single, scarlet.

The following varieties are recommended on the basis of a year's behavior at Cornell:

SECTION I. SINGLE VARIETIES.

A. Foliage reddish.

Barillet, Ami. Dark scarlet; not up to the standard of profuseness. Curious, and interesting to amateurs and plant-breeders.

AA. Foliage green.

Scarlet.

Downie, John. Very early, and very productive; stems suitable for cutting.

Scarlet orange.

Fife, Duchess of. Quite productive especially in latter part of season; suitable for cutting.

Cardinal.

Cowan, John. Very early and very productive; stems suitable for cutting.

Crimson.

Gartenfalter. Dark crimson; a strong color, and quite pure at close of

the season ; not everyone likes this color ; too late to be an ideal variety, although it was productive enough late in the season.

SECTION II. POMPON VARIETIES.

A. Type not fixed ; quality, quantity and position of colors variable.

Beauty Inconstant. White, yellow and various shades of red or pink ; two or more colors may be combined in the same flower ; very attractive ; was not as prolific last year as Pompons should be and commonly are.

AA. Type well fixed.

B. Rays cut, or imbricated.

White.

Guiding Star. The nearest to pure white in this class that I know of. There is a little yellow at the base of each ray which ought to be eliminated to make the variety entirely perfect.

BB. Rays not cut, or imbricated.

C. Colors single.

Orange.

Kleine Domitea. Early, prolific.

Scarlet Orange.

Vivid. Perhaps the most intense and brilliant color of all tried last year ; not as productive as the average pompon in 1896. Possibly the color is nearer to pure scarlet than scarlet orange.

CC. Colors, two or more.

Whitish, shading to crimson.

Little Najade. Recommended chiefly because very early and very prolific. In small collections the choice would be merely one of preference of color between this and *Eleganta.*

Pinkish.

Eleganta. Face shades of jacqueminot (Kohn), reverse pink (Mathews). The nearest approach to a pure pink I know of in this class, taking *A. D. Livoni* as the standard of pure pink among dahlias.

SECTION III. LARGE-FLOWERING VARIETIES.

A. Leaflets deeply lobed.

White, margined red.

Fern-Leaved Beauty. Flowers too few, and small for an ideal commercial variety. This is of the greatest interest to the amateur and plant-breeder. Habit dwarf. Suitable for bedding.

AA. Leaflets of the common type *i. e.*, not deeply lobed.

B. Colors single.

White

Purity. The nearest to pure white in this class, that we had. There is a slight amount of yellow at the base of each ray which tones the general effect very slightly and should be eradicated from the ideal white. Early, prolific, and habit ideal. Excellent for cutting.

White, suffused blush pink.

Ruth. The pinkish tinge is so faint as to allow the flower to pass for a white at a little distance. In small collections it would be an equal choice with *Purity.* Must be distinguished from *Miss Ruth.*

Yellow.

Pluton. Very early and very prolific, far more so than any other yellow dahlia of the old school in trial of 1896. Rather formal and stiff. For some reason it was often not double enough with us to be entirely globular.

Buff.

Crown Prince. Flowers very large, late, and rather few. The plant was one of the very tallest. Foliage very coarse.

Pink.

Livoni A. D. Pure pink with no trace of a secondary color. Flowers medium sized, profuse. *Ethel Vick* seems to be exactly the same thing.

Scarlet.

Blaine James G. Flowers early, very large, and very profuse. Great size does not seem to bring coarseness or vulgarity.

Purple.

Honest John. A peculiar shade, not the ordinary purple. Early, very prolific. Habit very good. This is a very attractive variety and most people like it.

Salmon.

Askins, Mrs. Reverse salmon pink ; flowers sometimes freaked with pinkish rays ; late and rather few blooms in 1896 ; described by Wilmore as "deep fawn."

BB. Colors two.

C. Both colors on some of the rays.

White and lilac.

Alexis, Grand Duke. Late and scanty bloom in 1896 ; this is well worth the having for amateurs even if there should be only two or three flowers ; I know of no other dahlia having this particular form ; inner rays tipped lilac.

CC. Both colors on all rays.

D. Shaded ; *i. e.* colors about equally divided between lower and upper half of face of each ray.

Purple and magenta.

Ruby Queen. Purple madder brown shading to dark purple and magenta; The coloring is very rich and bears close inspection ; it was very attractive and made about an equal number of friends and foes in 1896.

DD. Variegated ; i. e., streaked and dotted.

Yellow, streaked cardinal.

Bolton, Rev. C. W. Very early and very prolific ; flowers borne well above the dwarf, compact, bushy foliage, on long slender stems suitable for cutting. Easily the best variegated dahlia of the globular type in the trial of 1896.

Straw, streaked magenta.

Fawcett, Lucy. Early ; prolific ; tall and suitable for cutting. There are really two secondary colors beside the straw-colored ground and sometimes the flowers come " solid " in either of these secondary colors ; these varia-

tions have been saved and perpetuated. The variability is one of the good features of this variety for amateurs.

Maroon.

Sladden, John. Very dark maroon. This gave few and late blooms in 1896 at the Cornell Experiment Station. If I could have only two dark colored flowers of the globular type I should select *Honest John* as being dwarfer, earlier and more productive.

DDD. Margined.

White, margined, cherry red.

American Flag. Flowers never more than medium sized, and not early in 1896. Moderately productive. Type pretty well fixed ; well named and always attracts attention.

SECTION IV. CACTUS VARIETIES.

A. Flower stems drooping.

Yellow.

Lemon Giant. Light yellow ; flowers very large ; flower stems very long, slender and naturally drooping.

AA. Flower stems erect.

B. Colors single.

White.

Peart, Mrs. A. See Fig. 24.

White.

Patrick, Henry. This was late and produced many imperfectly blown flowers. *Harry Freeman*, which Turner, 1896, p. 20, says is an improvement on *Henry Patrick* was a week later and otherwise much the same as regards flowering. The habit is different. No small garden needs both.

Scarlet.

Kynerith. Dark scarlet, edged cardinal.

Scarlet.

Agnew, Wm. Scarlet toned with an infusion of scarlet orange. Much earlier than its class and prolific ; color very brilliant in sunshine or shade. Redder than the variety *Orange Scarlet.*

Salmon.

Michell, Henry G. Reddish salmon ; flowers very large.

Salmon.

Little Cactus.. Has the dwarf habit and small flowers of a pompon but hardly sufficient profuseness. Seems to have possibilities for the plant-breeder.

Red.

Black Prince. The darkest red I know. Form peculiar and interesting. The rays are like the sides and bottom of a long slender box.

Magenta.

Rosacactus. (Deegen, 1892, p. 5, No. 4019.) Rosy magenta, a color displeasing to some. Early and very prolific. Flowers very large and very few imperfectly blown.

Maroon.

Bragg, John. Purple madder brown ; usually described as dark maroon, nearly black.

Matchless. Velvety maroon.

BB. Colors two or more.

Red and White.

Maid of Kent. The shade of red is between scarlet and cardinal. It shades through pink to a brilliant white. The texture and luster are very remarkable. Form about half way between the globular and cactus type.

Salmon and pink.

Oban. Salmon and crimson pink, iridescent, a peculiar and delicate combination of colors. Described by Peacock as rosy lavendar, overlaid delicate silvery fawn. The variety sent as *Ernst Kelway* was identical with this. *Lady Marsham* is similar but has more of the rose color.

Pink and white.

Nymphæa. Shell pink, inner rays at times nearly white. Sometimes slightly fragrant. These flowers in a vase are often compared to water-lilies. It is perhaps the most famous of American varieties and has had much to do with bringing about a revival of interest in dahlias.

WILHELM MILLER.

Bulletin 129. February, 1897.
Cornell University Agricultural Experiment Station.
ITHACA, N. Y.
CHEMICAL DIVISION.

HOW TO CONDUCT FIELD EXPERIMENTS WITH FERTILIZERS.

By G. C. CALDWELL.

PUBLISHED BY THE UNIVERSITY,
ITHACA, N. Y.
1897.

ORGANIZATION.

BOARD OF CONTROL:

THE TRUSTEES OF THE UNIVERSITY.

STATION COUNCIL.

President, JACOB GOULD SCHURMAN.

Hon. A. D. WHITE,	Trustee of the University.
Hon. B. F. TRACY,	President State Agricultural Society.
Professor I. P. ROBERTS,	Agriculture.
Professor G. C. CALDWELL,	Chemistry.
Professor JAMES LAW,	Veterinary Science.
Professor J. H. COMSTOCK,	Entomology.
Professor L. H. BAILEY,	Horticulture.
Professor H. H. WING,	Dairy Husbandry.
Professor G. F. ATKINSON,	Botany.

OFFICERS OF THE STATION.

I. P. ROBERTS,	Director.
E. L. WILLIAMS,	Treasurer.
E. A. BUTLER,	Clerk.

ASSISTANTS.

M. V. SLINGERLAND,	Entomology.
G. W. CAVANAUGH,	Chemistry.
L. A. CLINTON,	Agriculture.
B. M. DUGGAR,	Cryptogamic Botany.

Office of the Director, 20 Morrill Hall.
The regular bulletins of the Station are sent free to all who request them.

BULLETINS OF 1897.

124. The Pistol-Case-Bearer in Western New York.
125. A Disease of Currant Canes.
126. The Currant-Stem Girdler and The Raspberry-Cane Maggot
127. A Second Account of Sweet Peas.
128. A Talk About Dahlias.
129. How to Conduct Field Experiments With Fertilizers.

CORNELL UNIVERSITY, Ithaca, N. Y., Feb. 27, 1897.

HONORABLE COMMISSIONER OF AGRICULTURE, ALBANY.

Sir:—The very commonest and most urgent question which the farmers ask of us is how to tell what fertilizer their land needs; and this is the very question which cannot be answered save by getting the answer directly from the very soil and the very crop of which the knowledge is wanted. This means that the farmer must experiment and observe. How much good he may derive from this experiment will depend upon how accurate he is, and especially upon how much he knows about soils and the requirements of plants. In all our extension teaching, we have found no specific need so great amongst the grown-up farmers as the means of answering the question of how to fertilize the land. This little paper will put the diligent farmer in the way of finding out; and it is hopefully submitted as one of the bulletins of the Experiment Station Extension, or Nixon, bill.

L. H. BAILEY.

Plan of a set of plats upon which the farmer may ask the soil and the plant what fertilizers are needed :

1	S plat.
2	K plat. 20 lbs. muriate of potash.
3	N plat. 20 lbs. nitrate of soda, or 40 lbs. tankage or dried blood.
4	K N plat. { 20 lbs. muriate of p tash, 20 lbs. nitrate of soda; or { 20 lbs. muriate of potash, 40 lbs. tankage, etc.
5	O plat. No fertilizer.
6	P plat. { 40 lbs. plain superphosphate with 15% phosphoric acid.
7	K P Plat. { 20 lbs. muriate of potash, 40 lbs. superphosphate.
8	N K P plat. { 20 lbs. nitrate of soda, 20 lbs. muriate of potash, 40 lbs. superphosphate ; or { 40 lbs. tankage, etc., 20 lbs. muriate of potash, 40 lbs. superphosphate.
9	N P plat. { 20 lbs. nitrate of soda, 40 lbs. superphosphate; or { 40 lbs. tankage, etc., 40 lbs. superphosphate.

Size of plats 1-10 acre. Upon each plat the same crop is to be grown, care being taken that the seed is pure and that each plat receives exactly the same amount of seed.

(S, stable manure ; K, potash ; N, nitrogen ; P, phosphoric acid ; O, no fertilizer).

HOW TO CONDUCT FIELD EXPERIMENTS WITH FERTILIZERS.

Water and its constituents hydrogen and oxygen, and carbon, nitrogen, phosphoric acid, potash and lime are the chief components of every crop that the farmer or the horticulturist produces. If the quantity that the crop can get of any one of them is too small for the making of a good yield, the yield will not be sufficient no matter how much there may be of all the others. If the quantity of any one of them is more than enough for a good yield, it is only foolishness to supply any more of that substance in fertilizers. The supply of water and its constituents, and of carbon, are practically beyond the control of the crop-grower except in so far as water may here and there be supplied by irrigation, or may everywhere be conserved by shallow surface tillage properly managed. The supply of lime is usually large enough in ordinary arable soils. Therefore only nitrogen, phosphoric acid and potash are left to be looked after ; these, as every consumer of commercial fertilizers knows, are the things that he pays for in whatever of these fertilizers he buys.

By the introduction of leguminous plants, such as clover, vetch, lupine, peas, beans and the like, into his rotations, he may save himself from the necessity of buying so much nitrogen as he might otherwise have to get in order to preserve the proper balance of the plant-foods in his soils. These crops, as almost every farmer knows, can get a part of their nitrogen from the air ; and they will in general get more of it from the air and less from the soil the poorer the soil is in available nitrogen, and the richer it is within certain limits in potash and phosphoric acid.

Every ordinary arable soil has far more than enough of nitrogen, phosphoric acid and potash for the production of a good many crops ; and yet there are many such soils which will not yield paying crops unless fertilized with one or more of these very same plant-foods.

It may be taken for granted that an acre of every such soil contains in the uppermost twelve inches at least 5,600 lbs. of nitro-

gen, 5,000 of potash and 3,800 of phosphoric acid. These quantities are from 50 to 500 times greater than those sold off the farm in any crop. There is at least 50 times as much nitrogen in such a soil as is sold in any part of any crop, and much oftener 100 or even 200 times as much. There is at least 100 times as much potash as is carried off the farm in any part of a crop sold, and oftener 500 times as much. Similar figures might be given for phosphoric acid. Why, then, must we fertilize our soils, in one way or another?

The one most important reason is that these plant-foods in the soil are for the most part in an insoluble, or as very commonly said, unavailable form, and that they usually become available only little by little each year. That they do thus become gradually available, is clearly shown by some of the experiments of Lawes and Gilbert, of England; some of their plats have yielded crops of wheat and other cereals now for fifty years and more, without any manure.

It may be, however, that one of these foods does become available year by year in large enough quantities to contribute its share towards a good yield of some crop, provided that there is enough of the other two, but that there is in fact not enough of the other two; or it may be that enough of two of the foods will become available fast enough each season for a good crop, but that the other one will not; there will be only a poor crop in either case.

There are cases in which it would be only folly, with some thousands of pounds of the one or the two foods in the soil, and in such a condition that the crop grown on it can get all it needs for a good yield, (at least for one year, and probably for the next year, and even for a few years more), to buy these foods in commercial manure; nor would it be the height of wisdom to keep putting them on the soil year after year in stable manure, since that also contains the three foods under consideration, as well as other useful substances.

There are therefore two ways of using manures of any kind, stable or commercial. One may he called the blind and unbusiness-like way, the other the sharp and business-like way. We will consider only the second way.

The man who follows this second way, realizes that it may not be necessary to supply every crop on every soil with all three of the plant-foods mentioned above. He knows that different crops, while needing all these foods do not need the same quantities of all of them; he may suppose that this soil or that soil on his farm will yield an ample supply of one or two of these foods for as big a crop of some one kind as he wants to get, and he realizes that it may be profitable for him to find out what the real state of the case is.

The only way to get this information is the way by which pretty much all that we know about agriculture has been learned—by experiment. The crops that it is most profitable for him to raise must be fed, on the soil upon which he wants to raise them, with these three plant-foods, one by one, and with mixtures of them in the four combinations only that are possible. This is no easy road to learning; but for an intelligent farmer who has any disposition at all to study his business it will be pleasant work, and will put some variety into his otherwise too monotonous occupation.

I propose, then, to give full and simple directions for making these experiments in as reliable a manner as possible, and with the least possible expense and labor.

The selection of the field.—The field should be as uniform in character throughout as possible, and should have borne the same crop all over, at least in the preceding year, and should have been manured alike all over for that crop. If the field has been pretty well exhausted by a three or four-year rotation, more decisive results will probably be obtained than if it is in good condition. If not level or nearly so the slope should be as uniform as practicable. The underdrainage should be at least fairly efficient and uniform. The field upon which it may be most desired to make the experiment may not meet all these requirements; but it is probable that a fair approach to it can be made in most parts of this state.

The size, shape and arrangement of the plats.—The size should depend on the uniformity of the soil; for a very large field, and not fairly alike in the character of the soil and previous manuring

and cropping, larger plats would be advisable than for a smaller field of even character. The size of the plat must be determined also by the kind of crop that is to be experimented with. For a vineyard it should be larger than for corn; and for corn larger than for wheat or any similar sowed crop.

Long and narrow plats are generally considered as better than square ones, or broad and short ones. One advantage gained by long and narrow plats is that if there is unlikeness in strips across the field, all the plats can be laid out so as to run across those unlike strips; all the plats will then gain or lose alike.

The best arrangement, then, is to have plats as narrow as they can be and still carry a reasonable number of rows of the crop, and, unless the field is too large, extending from one side to the other, and across all unlike strips. Such an arrangement would reduce the labor of planting and tillage to a minimum, besides securing the probable advantage of greater evenness in results.

A set of plats seventeen and one-half feet wide would carry five rows of corn or potatoes, with three and one-half feet between the rows; there would then be three rows to harvest for the measurement of the crop, the two outside rows being rejected. For cereals, as wheat, rye, barley and oats, plats as wide as could be sown with the drill, with two or three feet vacant spaces between the plats, would answer. For small fruits, plats carrying three rows should be taken, the fruit of the inner row only being harvested for the measurement of the crop.

The fertilizers.—For *phosphoric acid* use what is called plain superphosphate. Dissolved bone black comes nearest to this of any fertilizer in the market. One responsible firm guarantees its dissolved bone black to contain sixteen to eighteen per cent of available phosphoric acid.

For *potash* use the high-grade muriate, which is always of good quality when obtained from reputable dealers. Only in exceptional cases would it be better to use the more expensive sulfate.

For *nitrogen*, wherever the fertilizer can be applied as a top dressing on the growing crop in early spring and again in early summer, use nitrate of soda, the cheapest nitrogen fertilizer on the market. But if for any reason it is impracticable to apply the nitrogen in this manner, use fine ground tankage or dried and

ground blood and meat; the former is a little cheaper. Either of them can be mixed with the phosphate and the potash and applied at the time when the seed is put in the ground, or earlier.

The quantity of the fertilizer to be applied.—A liberal dressing will be more likely to give a decisive answer to the question put by the experiment than a scanty dressing will. I would recommend the following quantities per acre: of nitrate of soda, 400 pounds, or of tankage or dried blood used instead of nitrate of soda, 600 pounds; of plain superphosphate, 800 pounds; of muriate of potash, 800 pounds. The fertilizers should be dry and finely powdered, and if applied together should be first very thoroughly mixed.

The cultivation of all the plots of the same set should be as nearly alike as possible. Therefore the whole of that portion of the field selected for any one set of experiments should be plowed and otherwise prepared for fertilizing and seeding on the same day; all the fertilizer that is to be applied and the seed should be put in on the same day. If nitrate is to be used as a top dressing it should be applied on all the plots of a set on the same day Each cultivating or hoeing of the plots of one set should be done. and the crop of all the plots of a set should be harvested, on the same day. As soon as practicable after every rain, every plat should be surface stirred to the depth of two or three inches, in order to conserve the moisture.

All these directions being followed, differences between the yields of different plats, due to any other causes than differences in the fertilizing, will be reduced to a minimum, and the results due to differences in fertilizing will be likely to come out more clearly.

The number of plats for one complete set of experiments and the manner of fertilizing them is shown in the diagram at the beginning of this bulletin; the size of the plat is supposed to be one-tenth of an acre. The abbreviations used are K for potash, P for phosphoric acid, N for nitrogen, O for no fertilizer, and S for stable manure, if it is desired to have a plat so fertilized in order to show whether there is profit in using any combination of commercial manures instead of the home-made product.

For the sake of economy in cost of fertilizers and labor, the

size of the plats can be reduced to one-twentieth of an acre; if the field is fairly uniform in character, the results with smaller plats might be just as reliable as those with larger plats. Of course only half as much of each fertilizer will be required on plats half as large as those indicated in the diagram.

The growing crops should be looked over from time to time, and a record should be kept of any differences observed between the different plats, of attacks of insect pests or of fungous diseases. A record of the weather should be kept.

The harvesting of the crop.— In carrying out this part of the work, allowance must be made for the possible growth of the roots of one row into the feeding-ground of the adjoining rows; thus the outside row of one plat may steal food from the next plat that was not intended for it; hence the directions to exclude the two outside rows of each plat, one on one side and the other on the other side, and not to include the crop of those rows in the harvest measured, are important. Since this cannot be done conveniently with wheat and other small grains, it is recommended to leave vacant spaces of two feet between the plats.

In measuring the crop, due credit should be given for every part of it that can be utilized in any way; if corn, not only the seed, but the stalks; if wheat, oats, etc., the straw as well as the seed; if potatoes, of course only the tubers.

The results.—In spite of all the care that may be taken in carrying out these soil tests, irregularities will appear in the results, sometimes so great that it is not easy to decide what their real meaning is; weather, soil, tillage and fertilizer work together for the making of the crop on each of the plats. All the plats suffer alike in bad weather and rejoice alike in good weather; the tillage has been the same for all the plats; all the plats were planted on the same day; only the fertilizing is different, because we made it so. The soil we suppose to be at least fairly uniform throughout; if, however, it does differ seriously from end to end of the field, all our long and narrow plats run across these irregularities and should be affected alike by them.

There may, however, be differences not easy to detect in the soil of different plats, by which the growth on one plat may be specially favored, or by means of which the fertilizer may be bet-

ter utilized. Whatever the reasons may be they will tell upon the results but will make less trouble for us the more careful we are as to everything that we can control.

It is possible by a careful study of the results to correct some of the discrepancies. A few years ago a German agricultural chemist proposed a method for making such corrections by which the results could be evened up and made to show much more clearly what the soil and crop experimented upon require in the way of plant-food. The explanation of this method could not be made clear without illustrations, and such illustrations would be more interesting if drawn from actual experiments carried out in this country.

The writer of this paper will be glad to correspond with any farmers or horticulturists of this state who are disposed to try this method of field experiments, and answer any questions about the matter, go over the results obtained, apply the corrections according to the method above mentioned, and finally to issue in another bulletin early next year an account of all the experiments reported to him.

G. C. CALDWELL.

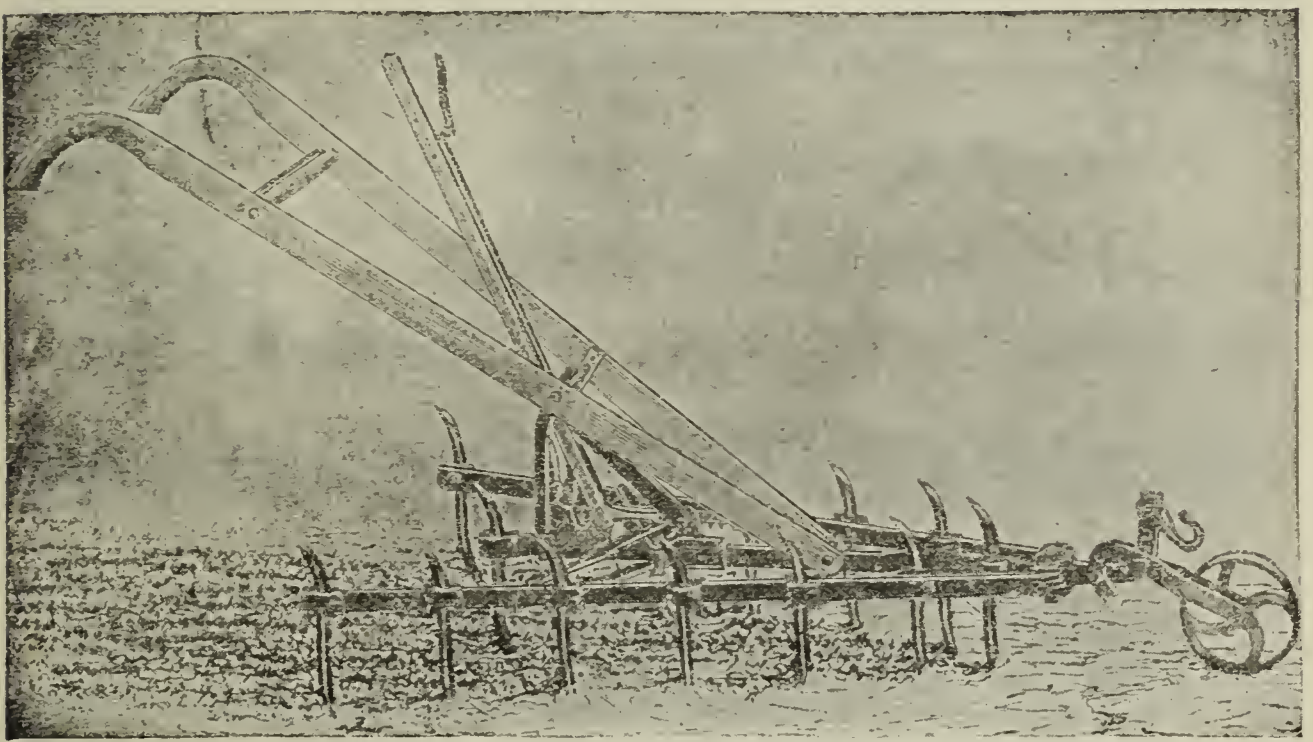
Bulletin 130. **March, 1897.**

Cornell University Agricultural Experiment Station.

ITHACA, N. Y.

AGRICULTURAL DIVISION.

Potato Culture.



By I. P. ROBERTS and L. A. CLINTON.

PUBLISHED BY THE UNIVERSITY,
ITHACA, N. Y.
1897.

Office of the Director, 20 Morrill Hall.
The regular bulletins of the Station are sent free to all who request them.

BULLETINS OF 1897.

124. The Pistol-Case-Bearer in Western New York.
125. A Disease of Currant Canes.
126. The Currant-Stem Girdler and The Raspberry-Cane Maggot.
127. A Second Account of Sweet Peas.
128. A Talk About Dahlias.
129. How to Conduct Field Experiments With Fertilizers.
130. Potato Culture.

POTATO CULTURE.

Many experiments have been conducted by different experiment stations to determine the fertilizers best adapted to potatoes, various varieties have been tested, but comparatively little work has been done to determine the possibility of making available the potential plant-food already in the soil and to determine the effects of extra good tillage upon crop production. That the average yield of potatoes in New York is far below what it should be is shown by the last United States Census Report, in which the yield is given as 68.8 bushels per acre. In 1895, a most favorable year for potatoes, the average yield for the state was about 122 bushels per acre. With a view to determine the effects of tillage upon crop production the following experiment was planned.

The land selected for the work was a gravelly soil which had been subjected to a regular four-years' rotation, consisting of wheat, clover, corn and oats. In 1894, the land was all planted to corn. This corn land was fertilized with barn manure applied during the fall and winter of 1893-4 at the rate of about 10 tons per acre. In the spring of 1895 there were measured off 46 one-twentieth acre plats, and a portion of these plats was selected as the ones upon which to conduct an experiment in potato culture.

*The land was prepared for planting as follows: All plats were plowed late in the fall of 1894 after the corn was removed. In the spring, all plats were gang-plowed about May 1st, and the ground thoroughly harrowed, marked and furrowed with a double mold board plow and planted to potatoes May 3d and 4th. It should be remembered that this ground was a loose, open soil, and that before planting it was most thoroughly fitted. No amount of after tillage can ever make reparation for the failure to fit the ground properly before planting. Fig. 33 shows the gravelly nature of the soil. The photograph was taken in the fall of 1896 after the potatoes had been harvested This was the second time the field had been raked over and the stones removed.

*Prof. Geo. C. Watson was in immediate charge of the work in 1895.

33.—*Showing the gravelly soil on which the potatoes were grown.*

The record of planting for 1895 is as follows:

May 3, planted plats 21 and 22 to Rural New Yorker No. 2.

May 4, planted plats 23 and 24 to Orphan potatoes.

May 4, planted plats 25 and 26 to Rural New Yorker No. 2.

May 4, planted plats 27 and 28 to American Wonder potatoes.

The potatoes used for seed were large marketable ones and were cut to one strong eye to the piece and planted in rows 3¼ feet apart with the pieces 14 inches apart in the row. They were covered with a hoe to the depth of about four inches. The first cultivation was on May 10 with a Breed's weeder. It may be said that on this gravelly, loose soil, such an implement did good work, while on soils containing a large percentage of clay its work was not as satisfactory with us.

The second cultivation was given on May 17, when the spike-tooth harrow was used on all the plats. The importance of this early tillage before the potatoes are up can hardly be too highly estimated. The spring rains form a crust on the surface which needs to be broken up, innumerable small weeds which are just showing themselves through the soil are killed, a surface earth mulch is established which serves to prevent the loss of moisture by evaporation, and in many ways this harrowing of the ground before the potatoes show themselves is most beneficial to the success of the crop. Again on May 23, May 29 and June 6, all potato plats were cultivated with a spring-tooth cultivator. It will be noticed that up to this time the plats have been treated alike and already given as many cultivations as the potato crop ordinarily receives. From this time the tillage of the various plats, for comparison, varied in frequency. The complete record of the cultivation given is as follows:

May 3 and 4, all plats planted.

May 10, all plats cultivated with Breed's weeder.

May 17, all plats harrowed with spike-tooth harrow.

May 23, all plats cultivated with spring-tooth cultivator.

May 29, all plats cultivated with spring-tooth cultivator.

June 6, all plats cultivated with spring-tooth cultivator.

June 17, plats 21, 23, 25 and 27 cultivated.

June 24, all plats cultivated.

July 2, plats 21, 23, 25 and 27 cultivated.

July 9, all plats cultivated.

July 15, plats 21, 23, 25 and 27 cultivated.

July 23, all plats cultivated.

July 29, plats 21, 23, 25 and 27 cultivated.

August 5, all plats cultivated.

The tillage continued until the vines so covered the space between the rows that the cultivator could no longer be used without injuring the foliage.

The following table shows the results obtained from the different plats.

CULTURE EXPERIMENTS—POTATOES.

1895.	Number of cultures.	Yield per acre. Bushels.
Plat No. 21...	13	378
Plat No. 22...	9	415
Plat No. 23...	13	319
Plat No. 24...	9	414
Plat No. 25...	13	304
Plat No. 26...	9	311
Plat No. 27...	13	350
Plat No. 28...	9	330

The average from plats given thirteen cultivations was 337.5 bushels per acre. The average for nine cultivations was 367.5. As has been mentioned, this year was especially favorable for potatoes and the average for the state was extra high, being 122 bushels per acre.

In 1896, the experiment was continued. The adjoining plats selected were a part of the series which had been planted to corn in 1894 and 1895. After the corn was harvested, all plats were drilled to wheat as a cover crop. This wheat made fair growth and when plowed under in the spring added some humus to the soil. Other than this no fertilizer or manure was used, and two crops of corn had already been removed since a light application of barn manure was made. That the results might be of more value, it was decided to give to some of the plats only ordinary tillage, to other plats extra good tillage and to others excessive tillage.

The record of the preparation of the soil for the potato crop of 1896 is as follows: The plowing was done as early in the spring

as the condition of the soil would permit and the land was immediately harrowed and rolled. Before planting, the Acme harrow was used to pulverize and loosen the surface soil. Rows were laid off at distances of 3¼ feet and opened with a double mold-board plow. The seed was from selected stock and was cut so that two or three eyes were on each piece. More care was taken to have each piece of potato of good size than to have a certain number of eyes to each piece. Seed was dropped at distances of 14 inches in the row and covered with a cultivator to a depth of about 4 inches. All plats were planted May 9 and harvested October 9. The complete record of the plats will be seen in the table below.

The first tillage was given May 20, before the potatoes were up, when all plats were thoroughly harrowed with the spike-tooth harrow. The cultivation was continued until August 6, at which time the vines so covered the space between the rows that tillage could no longer be continued without producing serious injury.

RECORD OF POTATO PLATS FOR 1896.

Plat No.	Date of planting.	No. of cultivations.	Date of digging.	Yield per acre. Bushels.	REMARKS.
6	May 9	7	Oct. 9	318.2	Fertilized with 200 lbs. muriate of potash and 300 lbs. of acid phosphate.
7	"	7	"	310.5	Fertilized with 200 lbs. sulphate of potash and 300 lbs. of acid phosphate
8	"	7	"	350.3	Comparable.
9	"	11	"	338.1	
10	"	3	"	280.	
11	"	3	"	299.7	Comparable.
12	"	7	"	341.6	
13	"	7	"	334.	Variety test.
29	"	7	"	360.6	Fertilized with 200 lbs. of muriate of potash and 300 lbs. of acid phosphate.
30	"	7	"	333.5	Fertilized with 200 lbs. of sulphate of potash and 300 lbs. of acid phosphate.
31	"	7	"	346.5	Comparable.
32	"	11	"	339.	
33	"	3	"	245.8	

Those marked "comparable" are to be studied for the effect of tillage only.

In addition to the cultivation which was given these plats they were sprayed four times, once with Bordeaux mixture* alone and three times with a Bordeaux and Paris Green mixture.

In addition to the series of plats, a measured acre was selected which had been in timothy and clover the previous year. The soil was a clay loam and during the winter of 1895-6 was given a light top-dressing of barn manure. In the spring the coarse material was raked off with a horse rake, and the land was fitted and planted to Rural New Yorker No. 2 potatoes. This acre received six cultivations and gave a yield of 314 bushels.

AVERAGE YIELD PER ACRE FOR 1895.

Plats receiving 13 cultivations, . . .	337.5	bushels.
" " 9 "	367.5	"

AVERAGE YIELD PER ACRE FOR 1896.

Plats receiving 11 cultivations, . . .	335.9	"
" " 7 "	343.1	"
" " 3 "	275.2	"
The one-acre field, 6 cultivations, . .	314.	"
Fertilized plats receiving 7 cultivations,	330 7	"
Average yield per acre for New York state (United States Census), 1890, . . .	68.8	"
Average yield per acre for New York state, 1895, ...	122.	"
Average yield per acre for all plats and the one acre at Cornell University for 1895 and 1896, ...	333.34	"

From these results we are led to conclude that in potato raising the matter of tillage is too often neglected. The results obtained two years in succession without any application of fertilizer show that the average yield of New York state is far below what it need be. The soil on which these experiments were conducted was not more rich in plant-food than the ordinary soils. The average analyses of forty-nine soils shows the following amount of potential plant-food to be contained in an acre to the depth of eight inches :†

* The Bordeaux mixture was made as follows: Copper sulphate 6 pounds, quick lime 4 pounds, water 45 gallons.

† For more extended soil analyses see Roberts' "The Fertility of the Land."

Phosphoric acid, ...	4,219 lbs.
Nitrogen, ...	3,053 "
Potash, ...	16,317 "

An analysis of the soil from the plats on which the potatoes were grown shows the following amounts of potential plant-food per acre to the depth of one foot:

Phosphoric acid, ...	3,784 lbs.
Nitrogen, ...	3,074 "
Potash, ...	12,063 "

This computed to a depth of eight inches, for comparison with the previous analysis given, shows the following amounts:

Phosphoric acid, ...	2,523 lbs.
Nitrogen, ...	2,049 "
Potash, ...	8,042 "

It will thus be seen that with a soil containing little more than half the amount of potential plant-food ordinarily contained in soils, a yield was secured from three to four times the average yield of the state.

The fact has been mentioned that this soil was gravelly. In securing a sample for analysis we found in the surface foot 56.79 per cent of material fine enough to pass through a sieve of 18 meshes to the inch, and 41.85 per cent of gravel which would not pass through the sieve. The loss due to drying and waste was 1.36 per cent.

In the ordinary analysis of soils the gravel is not taken into consideration and only that part is now analyzed which passes through a sieve of 50 meshes to the inch. To determine more fully what potential plant-food was in the land, it was decided to analyze the gravel, or that portion which failed to pass through a sieve of 18 meshes to the inch. The result of the analysis showed the following amounts of potential plant-food locked up in the gravel of a surface foot of one acre of the land:

Phosphoric acid, ...	4,008.8 lbs.
Potash, ...	11,329.8 "

The manipulation that was necessary to cause the soil to pass through the sieve also broke down some of the gravel. It was found after sifting all the soil out that by working the remaining gravel with the hand a portion of it was so rotten that it

was easily disintegrated and fined, thus bringing into a more available condition its mineral fertilizing elements. By the frequent tillage given to the plats not only was nitrification promoted, but the mineral elements were partly liberated and made more available for the plant's use.

In a soil analyzing about one-half of the average in fertility, enough plant-food was liberated and made available by means of tillage alone to insure a vigorous plant growth. This partially explains why the application of chemical fertilizers on plats 6 and 7 and 29 and 30 failed to give any marked beneficial result. It is probable that had there been more moisture in the soil better results would have been shown from the fertilized plats, but under the existing conditions the fertilizer was applied at a loss as far as any effect was evident on the yield of potatoes. True, the fertilizers applied may be of some benefit to future crops, but the farmer can scarcely afford to purchase high-grade chemicals and apply them to his soil except for their immediate benefit to the succeeding crop, as it is well known that they become less readily available for the plant's use after having been in the soil for a considerable time. While this is true of the mineral fertilizers, it is more especially true of the nitrogenous, for if the most readily available form of nitrogen is applied, as in nitrate of soda, that portion of the nitrogen which is not made use of quickly by growing plants may be largely lost to the soil, being carried away by the drainage water.

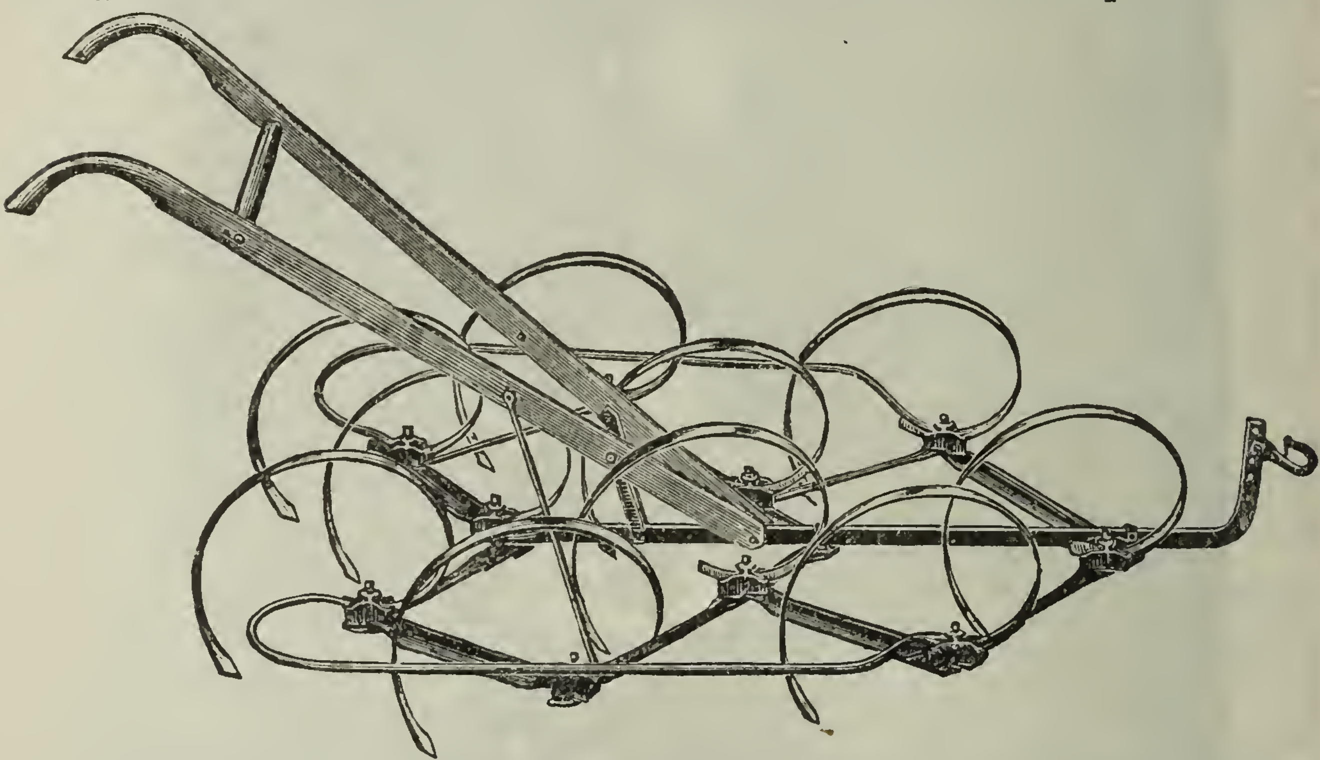
Shall the attempt be made, not only in potato culture, but with all farm crops, to substitute fertilizers for tillage? With potatoes at 25 cents per bushel and fertilizers at $25 per ton, is it good policy to purchase plant-food before an earnest effort has been made to utilize that vast store which nature has provided? If the effort has been made and the soil fails to respond satisfactorily, then it is not only justifiable, but it may be a wise policy to supplement the stores of the soil with additional readily available plant-food. The low average yield of the state is not so much due to lack of plant-food as to deficiency of moisture. It has been estimated by Professor King* that for

*The Soil, p. 155.

34.—*Tilling to conserve moisture in potato field.*

every ton of dry matter of potatoes produced there is required 422.7 tons of water. In the case of the average yield for 1896 with seven tillings when there was produced 343 bushels per acre, the amount of dry matter was 4,342.38 pounds, or 2.17 tons. To mature this amount would require some 917.25 tons of water. This was secured to the plants by early and deep plowing of the land to establish the earth mulch and to prevent loss of the spring rains, and then by frequent surface tillage the mulch was renewed to lessen the loss of moisture by evaporation.

The conservation of moisture by frequent tillage cannot be too strongly enforced. The liberal application of fertilizers, or the presence of large amounts of readily available plant-food



35.—*Cultivator well suited to potato culture during earlier period of growth.*

will prove of but little value if the moisture supply is deficient. The old notion that tillage must cease as soon as the potatoes blossom, is wrong. It should be continued as late in the season as the growth of the vines will permit. As the tops spread out and begin to cover the space between the rows, they partially shade the soil and thus lessen the loss of moisture by evaporation. The cultivator should be narrowed and the middle of the open space kept covered with a loose earth mulch (Fig. 34). The implement best adapted to this work is one having many small teeth so that it will leave the soil comparatively level. (See Frontispiece.) Fig. 35 shows an imple-

NOTES UPON PLUMS.

I. General Remarks.

Of all the important fruits, the common plum has the smallest American literature.* The time is perhaps not yet ripe for any extended treatise upon the plum, for in a large part of the country plum growing is yet in an experimental stage. In western New York, the business is reduced to a more definite and established basis than elsewhere in the country—unless possibly upon the Pacific coast—and a few notes upon this industry may therefore serve a useful purpose until a fuller treatise shall appear.

The types of plums.—The plum industry is very complex, because so many distinct species are concerned in the genesis of the cultivated varieties. In this state, only the European or domestic plums are grown to any extent, except that the Japanese types are now attracting much attention ; yet it will be worth our while to get a broad view of the subject by fixing the general basis of the plum industry in our minds. The plums cultivated in the United States belong to the following groups :—

I. Domestica or European types, *Prunus domestica.* Native to western Asia. Comprises the common or old-time plums, such as Green Gage, Lombard, Bradshaw, Yellow Egg, Damsons, and the like. The leading plums from Lake Michigan eastward and north of the Ohio, and on the Pacific slope.

II. The myrobalan or cherry-plum type, *Prunus cerasifera.* Native to southeastern Europe or southwestern Asia. Much used for stocks upon which to bud plums, and also the parent of a few named varieties, like Golden Cherry ; and DeCaradeuc and Marianna are either off shoots of it or hybrids between it and one of the native plums. See Bulletin 38.

III. Japanese types, *Prunus triflora.* Probably native to China. The type seems to be generally adapted to the United States, and

* The only American book I know devoted wholly to the plum is Eliphas Cope's "Practical Treatise on Plum-Growing," New Lisbon, O., 1888, 16 mo. pp. 45.

will certainly be of great value to both the south and north. See our Bulletins 62 and 106 for full accounts of these plums.

IV. The Apricot or Simon plum, *Prunus Simonii*. Native to China. Widely disseminated in this country, but little grown except, perhaps, in parts of California. See our Bulletin 51.

V. The Americana types, *Prunus Americana*. The common wild plum of the north, and extending westward to the Rocky Mountains and southward to the Gulf and Texas. Admirably adapted to climates too severe for the domestica plums, as the plains and the upper Mississippi valley. See our Bulletin 38 for accounts of all the native plums.

VI. The Wild Goose or hortulana types, *Prunus hortulana*. A mongrel type of plums, comprising such kinds as Wild Goose, Wayland, Moreman, Miner and Golden Beauty. No doubt hybrids of the last and the next.

VII. The Chickasaw types, *Prunus angustifolia* (or *P. Chicasa*). Native to the Southern states, and there cultivated (from southern Delaware southwards) in such varieties as Newman, Caddo Chief, and Lone Star.

VIII. The Sand plum, *Prunus Watsoni*. Native to Kansas and Nebraska. A bush-like species, little known in cultivation. A hybrid of this and the Western Sand Cherry is the Utah Hybrid Cherry. See our Bulletin 70.

IX. The Beach plum, *Prunus maritima*. Native to the coast from New Brunswick to Virginia. In cultivation represented by the unimportant Bassett's American ; also as an ornamental plant.

X. The Pacific coast plum, *Prunus subcordata*. Native to Oregon and California. Sparingly known in cultivation, chiefly in the form known as the Sisson plum (var. *Kelloggii*).

With these ten types coming into cultivatlon in the rapidly enlarging fruit zones of our immense country, who can forsee what the final outcome as to types and varieties may be !*

The remarks in the present paper are meant to apply only to the domestica and Japanese plums, chiefly to the former. In

*For an historical and philosophical sketch of our plums, see Bailey, "The Survival of the Unlike," p. 418.

respect to varieties, it is difficult to make any classification of those of the domestica stock. Perhaps the best that could be done would be to make four loose groups, as follows:

1. Damsons comprising very small firm plums of various colors, generally borne in clusters, the leaves mostly small. The run-wild plums of old roadsides and farmyards are mostly of the damson type. (Fig. 46 and title page.)
2. The green gages, comprising various smallish, green or yellow-green plums of spherical form and mostly of high quality. Reine Claude is the commonest representative of this group in this State. There seems to be no specific Green Gage generally propagated in this country. The name has now come to represent a class of plums.
3. Large yellow plums, such as Coe's Golden Drop, Washington, and the like.
4. Large colored plums, including the various red, blue and purple varieties, like the blue prunes, Lombard, Bradshaw, Quackenboss, etc.

In respect to hardiness of the different types of plums, it may be said that at Cornell the Japanese and domestica varieties are about equally resistant to cold. Neither of them bore fruit last year, but the winter of 1895–6 was one of very unusual severity. The Americana types are very hardy. Fig. 37 shows sprigs of the three types taken at blossoming time in 1896. The upper shoot is Abundance (Japanese), the middle one Jefferson (domestica), and the lowest one Quaker (Americana). In the two first, the fruit-spurs were entirely killed. Although the Americanas are so very hardy, we do not recommend them for market cultivation in western New York because they are inferior to the domesticas and the years are very seldom in which the domesticas are injured seriously by cold.

The leading type of plum for western New York will no doubt always be the domesticas. The Japanese varieties are important because they add variety to the list, and especially because they are rich in very early kinds and the fruit is so firm that it carries well; aside from this, the trees are vigorous and very productive, and they are less liable to the attacks of the black-knot and the shot-hole fungus than the domesticas are.

The plum orchard.—Coming now to the general question of plum growing, it may be said that the plum is emphatically a special fruit; that is, it is one which does not have a regular standing in the market as pears, apples or even peaches have, but is more or less dependent for its sale upon the general supply of other fruits. In other words, it is a fruit of secondary import-

37.—*A condition, not a theory. Showing how the winter of 1895-6 used up the fruit-spurs of Japanese and domestica plums, but did not injure the Americanas.*

ance, so far as the market is concerned. This being the case, it will readily be seen that it is not a difficult matter to overplant for the plum market. In western New York, the industry has been developed to a very important extent, but the production of fruit has probably not yet reached its zenith. Many of the orchards have been planted with no particular forethought, but

largely because some one else had done well with his plantation. It would be easy to figure up the prospective crops from the plum trees which are now growing in western New York and to see that the product would very likely over-stock the market. But it must be remembered that probably not more than half of these trees will ever produce full crops of fruit. The same remark will apply to any kind of fruit which is set in large quantities. The success of fruit-growing is so intimately connected with the thoroughness, care and business ability of the grower himself, that one can never prophesy what the results of any fruit industry are likely to be. In every fruit business there are likely to be a great many failures, from the commercial standpoint, and only a few pronounced successes.

The plum thrives upon a variety of soils, but it generally does best when planted upon clay loam. It usually thrives best upon lands which are suited to pears, or upon the heavier lands which are adapted to apples. Yet there are many varieties which thrive well upon lands which are comparatively light and sometimes almost sandy.

The stocks upon which plums are grown are very various. By far the greater number of the trees in the north are now grown upon the myrobalan stock, which is a species of rather slow-growing plum, native to southeastern Europe and southwestern Asia. This is the stock which is sometimes recommended in the older fruit books for the making of dwarf trees ; but unless the top is kept well headed in, the trees generally make normal growth upon it. Trees grown upon this root are usually larger and finer at one or two years of age than those grown upon other plum stocks, and the probability is that they are nearly as useful from the grower's standpoint as any other. However, there are some varieties which overgrow the myrobalan, and the stock is very likely to sprout from the ground and thereby cause trouble. I am convinced that the most ideal stock, from the standpoint of the grower, is the domestica plum itself, but it is more difficult to secure seeds of it, the stock is more variable and it is more likely to be injured in the nursery row by the leaf fungi ; therefore, as a matter of practice, the myrobalan has very generally supplanted it. In the southern states the peach is largely used as a stock

upon which to grow plums and it seems to be gaining favor in the north. It is undoubtedly a very excellent stock for sandy lands, and, in fact, is probably more preferable for such lands than the myrobalan itself. Some varieties—of which the Lombard and French Damson are examples—do not take well upon the peach. The Japanese plums are commonly worked upon the peach stock and they seem to make an excellent union with it and to give every promise of being hardy and durable. The Marianna stock, which is much recommended in the south, has not found great favor in New York.

Many of the varieties of plums are such slow and crooked growers in the nurseries that it is advisable to graft them or bud them upon some strong and straight stock. The Lombard is no doubt the best stock for this purpose which is now grown by nurserymen. The old Union Purple is one of the very best of stocks, but it is not grown much at the present time. All such varieties as Reine Claude, German Prune, Copper, etc., are probably best when top-worked upon some such stock.

Plum trees are usually planted when two years old from the bud, although some of the strong-growing kinds may be planted at a year old with the very best results. As a rule, plum trees are planted about as far apart as peaches are, that is, from 15 to 18 feet apart each way. Many growers prefer to plant them closer one way than the other and eventually to stop cultivation in one direction. If this system is used, they may be placed 18 or 20 feet apart one way, and from 10 to 12 feet the other way. The trees are pruned in essentially the same way that apple trees are, when planted. It is generally advisable to start tops as low as possible and yet allow of the working of the curculio catcher below them. This means that the limbs should start out from three or four feet above the ground. With the modern implements and methods of tillage, there is no inconvenience in working the land if tops are started as low as this.

The subsequent pruning of the plum tree has no special difficulties. About four or five main limbs are allowed to form the framework of the top, and in most varieties, especially those which are not very tall growers, the central trunk or leader may be allowed to remain. There is constant demand for information

as to whether young trees should be headed-in. There can be no positive answer to this question. If the trees are growing very vigorously, so that they become too tall and whip-like, it is best to head them in ; but it must be remembered that this redundant growth commonly ceases and the tree begins to spread when the bearing time arrives. If trees are making too vigorous growth, the real corrective of the difficulty is to stop the growth by withholding fertilizers or cultivation rather than by heading-in the tree. Vigorous heading-in only makes the growth the stronger. All this is a very different matter from the customary heading-in of old trees. Some growers prefer to let a plum tree take its natural open, spreading growth, whilst others desire to keep it sheared in to allow the trees to be planted closer together and to keep the fruit nearer the center of the tree. This is very largely a matter of personal preference and there are probably no very decided advantages in either system when it is carried out systematically and conscientiously. For myself, I believe that the heading-in of plum trees is practiced to too great an extent in western New York, but I should by no means be dogmatic in this opinion. It should be said that the plum tree will need pretty careful attention from year to year to keep the top in shape, to cut out and paint over all injured places and in other ways to protect the tree from accidents and from injuries of storm and insects.

In common with all fruits, the plum demands good tillage and liberal feeding if satisfactory results are to be obtained. The extended remarks upon the tilling and fertilizing of fruit lands which are made in our Bulletins 72, 102, 103, and also in 119 and 120, apply with full emphasis to the plum. Well-tilled trees should begin to bear when three years set, and, at eight and ten years of age, the prolific varieties should be bearing three bushels of first quality fruit in every good year.

Insects and diseases.—In respect to insects and diseases of the plum, it will not be necessary to say much upon this occasion. The black-knot is fully treated in our Bulletin 81. It is only necessary to say in passing that the knot is best kept in check by systematically cutting it out whenever it is seen. At all events, the grower should go over his orchard for it in the summer time

and again as soon as the leaves are off in the fall. If trees are thoroughly sprayed every year with Bordeaux mixture for the leaf-blight fungus, the black-knot will make comparatively few inroads into the orchard.

The blight which causes the leaves to fall in August or September is one of the most serious diseases of the plum orchard; but the disease can readily be kept in check by thorough spraying with Bordeaux mixture two or three times during the summer. We have found, at Ithaca that we can hold the leaves on until frost by sprayings which have begun about two weeks after the blossoms fall, and repeated two or three times during the season. A somewhat full account of these experiments will be found in our Bulletin 86.

38.—*Fruit-rot of the plum. The upper spur is dead, probably killed by the fungus.*

The fruit-rot is another serious difficulty of the plum. This is the work of a fungus. Many times the dead and dried fruit may be seen hanging upon the tree all winter, as shown in Fig. 38; and in such cases it is very likely that the fruit-spur will be killed as the upper one in the picture has been. In handling this disease, the first consideration is the fact that some varieties are much more susceptible to it than others are. The Lombard is one of the very worst. Again, if the fruit grows in dense clusters, the disease is more apt to be severe. The thinning of the fruit, therefore, is one of the very best preventives of the spread of the disease and at the same time, also, one of the most efficient means of increasing the size, quality and salableness of the product. It may, therefore, be expected to pay in

two directions. The specific treatment for the disease is to spray with Bordeaux mixture, applied in about the same manner as for the leaf-blight fungus. The treatment of this disease is more specifically explained in our Bulletin 86.

The recent incursion of the plum scale in western New York, which has created so much alarm, is fully treated in our Bulletin 83. This insect, although formidable, may be kept in check almost completely by thorough sprayings with strong kerosene emulsion in the winter time.

There still remains the curculio, or the insect which is the parent of the worms in the fruit. A full report upon this insect may be expected at a future time. It is enough for the present purpose to say that the mature beetle lays the eggs in the fruits when they are very small, usually beginning its work about as soon as the flowers fall. These eggs soon hatch and the little maggot bores into the fruit. Those fruits which are attacked whilst very young ordinarily fall from the tree, but those which are attacked when they are half or more grown may adhere to the tree but are wormy and gummy at the picking time. The mature beetles are sluggish in the mornings and are easily jarred from the trees. Taking advantage of this fact, the fruit grower may jar them into sheets or a large canvas hopper which is wheeled from tree to tree upon a wheelbarrow-like frame and under the apex of which is a tin can into which the insects roll. One of these hopper machines is seen in Fig. 39. There is a slit or opening in one side of the hopper which allows the tree to stand nearly in the middle of the canvas. The operator then gives the tree two or three sharp jars with a padded pole or mallet. The edges of the hopper are then quickly shaken with the hands and the insects roll down into the tin receptacle. In this receptacle there is kerosene oil, or it may be emptied from time to time. Just how long this machine is to be run in the orchard will depend entirely upon circumstances. It is advisable to use the catcher soon after the blossoms fall for the purpose of finding out how abundant the insects are. If a few insects are caught upon each tree, there is indication that there are enough of the pests to make serious trouble. If after a few days the insects seem to have disappeared,

it will not be necessary to continue the hunt. In some years, especially in those succeeding a very heavy crop, it may be necessary to run the curculio-catcher every morning for four or five weeks; but, as a rule, it will not be necessary to use it oftener than two or three times a week during that season; and sometimes the season may be shortened by one-half. The insects fall most readily when the weather is cool and it is, therefore, best to

39.—*The Geneva type of curculio-catcher.*

get through the whole orchard, if possible, before noon. Upon cloudy days, however, the insects may be caught all day. Although this may seem to be a laborious and expensive operation, it really is not so. A smart man can attend to 300 to 400 full-bearing trees in six hours, if the ground has been well rolled or firmed as it should be before the bugging operation begins. But whether the operation is troublesome or not, it is the price of plums and the grower must not expect to long succeed without it. The same treatment is essential to the saving of peaches and rarely, also, of sour cherries.

Varieties.—The most popular variety of the plum, and also one of the poorest, is the Lombard. Its redeeming merits are its great productiveness and the vigor and hardiness of the tree. The fruit is of o quality, it comes at a season when the market is full of plums and other fruits, it is very susceptible to the leaf-blight fungus and the fruit-rot, and its color is not of the best. The very fact that it is the commonest and cheapest plum would seem to indicate that it is not the best variety from which to make the greatest commercial success. I am convinced that the Lombard has been greatly overplanted; yet, I know of many orchards of it which are very successful commercially. In western New York the best markets are likely to be found for the early and late plums, and for those which have very pronounced colors, especially those which are dark red or purple. Some of the dark yellows are also very excellent for market fruits. Fruits of nondescript colors, like those which border on the ill-defined reds, the browns and the lemon yellows, are usually not profitable. There is some exception to all this in the case of the Reine Claude, which is a yellowish-green plum; but its great merit as a culinary variety and its established reputation save it from the general condemnation of plums of that class. There is also an exception in the small Damson plums which are highly esteemed in some markets, especially in Boston, for culinary purposes.

It would be impossible to give any list of varieties which would be adapted to any particular orchard. The question of varieties is very largely a personal one. Very much depends upon what ideal the grower has in his mind, and also upon his soil and location and the like. Amongst the plums which can be most confidently recommended for market in western New York are the following: Field, Bradshaw, Coe's Golden Drop, Hudson River Purple Egg, Italian Prune, Empire, Grand Duke, Arch Duke, Monarch, Gueii, Peter's Yellow Gage, Reine Claude and Copper. Amongst the Damsons, the French and the Farleigh are perhaps the best. Of the Japanese plums, the only ones which I would care to recommend for profit in western New York at present are the Red June, Abundance, Burbank and Chase. The Red June promises to be the best very early market plum for this region which I know. So far as known, the domestica and Japanese plums are self-fertile, but it is always the safest course to plant varieties in alternate rows.

II. VARIETIES OF PLUMS IN WESTERN NEW YORK.

By S. D. Willard.

An experience of a quarter of a century in cultivating the plum has afforded convincing proof that, upon my soil at least, this fruit is like many others in the fact that the list of varieties adapted to profitab e orchard production is limited in number. Some are tender in the wood, others defective in their foliage,* others maturing at the wrong period or possessed of other weak points that render them unfit to be grown in the commercial orchard of western New York. It will readily be seen that the result of my experience, as demonstrated in testing the various sorts of plums, has been with reference to the one idea of profit. Believeing that the descriptions contained in our fruit works and nursery catalogues,—the latter being in the main copied from writings regarded as authority on these subjects,—are oftentimes misleading to the planter and are followed by ventures that are alike unsatisfactory and unprofitable, I have taken pains to make descriptions directly from life. All enjoy the delicious quality of a favorite product, but how often the question is lost sight of, as to whether it can be grown in quantity and at a price that will enable us to supply it to others at a profit over and above the cost of production !

Soil and surroundings have their influence upon the health, vigor and productiveness of a variety; hence it is frequently found that a fruit may be a failure on one soil and a success elsewhere. This feature has been very marked in the cultivation of the strawberry, and it is likewise true of the plum. Careful observation has led me to believe that any tree which has an inherent weakness, either in foliage or wood, is to be looked upon with suspicion when considered as an orchard sort for the average

* Mr. Willard prefers to grow varieties which are not subject to the leaf-blight fungus, rather than spray for the disease. He has given particular attention to the choosing of resistant varieties, and this will account for his condemnation of certain varieties which are otherwise desirable. A tree which is seriously attacked by the leaf-blight is very likely to be injured by the succeeding winter.—L. H. B.

40.—*Various types of plums.* I., *French Damson* (*two fruits*); II., *Quackenboss*; III., *Hudson River Purple Egg* (*two fruits*); IV., *Grand Duke* (*two fruits*); V., *Monarch*; VI., *Diamond.*

planter. Being desirous of securing the largest line of varieties that might be of value, a selection was made from foreign catalogues of sorts highly commended, and these have been tested with results which, as will be seen, are not entirely satisfactory, as but few out of the entire number have made a record that would warrant their cultivation on any extended scale.

In the subjoined list, nineteen foreign varieties which I have thoroughly tested from direct importations are marked with an asterisk (*).

* *Arch Duke.*—A large, dark colored, very prolific plum, ripening abont the 25th of September at Geneva and often hanging much later ; flesh hard and a good shipper, hence an excellent late market variety for the orchardist and should be more largely planted. I bespeak for this variety future popularity. Originated by Thomas Rivers, Sawbridgeworth, England. See Grand Duke.

Baker Prune.—Origin, Collingwood, Canada. We obtained this variety several years since and from observing it as top-grafted in our orchard are much pleased with its habits of growth. It seems to have been grown many years where it originated and is said to be hardy and prolific. Fruit resembles the Italian Prune in color and quality, perhaps a trifle smaller and about two weeks later in ripening. Should its good characteristics be maintained upon further trial, I should regard it as the best of prunes for the commercial orchard.

* *Biltern.*—Another plum highly commended abroad for its excellence in quality and great productiveness, traits which were fully confirmed during the short period of existence of the trees after they began to make a crop, but they lacked the robust character required to maintain themselves, and, like their companions, found their way to the brush heap after setting their third crop.

Bradshaw (*Niagara*).—A variety now very well known in all the plum-growing regions of the United States. Unsurpassed for beauty and productiveness as well as great hardiness of tree, with a foliage so perfect as to contribute in an essential degree to its health. During the period of twenty-two years in which I have fruited this variety, I have never known it to cast its foliage prematurely ; hence, the oldest trees are apparently as healthy as though they had never borne a crop of fruit. Fruit large, oval, often with a slight neck ; skin reddish purple ; flesh yellow, rather coarse but juicy and good ; ripening from tenth to twentieth of August at Geneva. Its beauty as a market sort is unsurpassed and were its period of ripening in the month of July or past the middle of September might be regarded as one of the most desirable of all plums for the commercial orchard. It has been planted very extensively, and it is a question whether there are not enough now growing to meet the demands of the city fruit stands for years to come, as it cannot be regarded as a desirable sort for peserving purposes.

Canada Orleans.—A very productive variety of medium size obtained at Hamilton, Ontario. Skin light green to yellow shaded to light purple in the sun; quality good; ripening August 15th to 20th. Tree hardy, bearing good crops alternate years. Of no special value to the market grower.

Coe's Golden Drop.—Of English origin. Fruit large, oval or short egg-shape; skin light yellow; flesh rich and quality excellent when well ripened; requires a quick soil and favorable season to ripen it well. Tree slow, poor grower but very hardy; has produced best with me when top-worked on other strong growing sorts. In unfavorable seasons has shown inclination to rot, but it may be regarded as one of the good yellow plums. This plum, or something exceedingly like it, has been sent out on the Pacific Coast as a prune.

Coe's Late Red.—An English variety. Fruit medium size; skin light purplish red; flesh yellow; very firm and excellent for preserving or shipping; productive and late, ripening in October and frequently hanging well into November. The late John J. Thomas once said to me, if he could have only one variety of plum, this would be his choice because of its lateness and value for culinary purposes. As a tree, its growing habits are unsatisfactory, and, therefore, it will never be popular with nurserymen. It will do best top-worked on vigorous growing sorts.

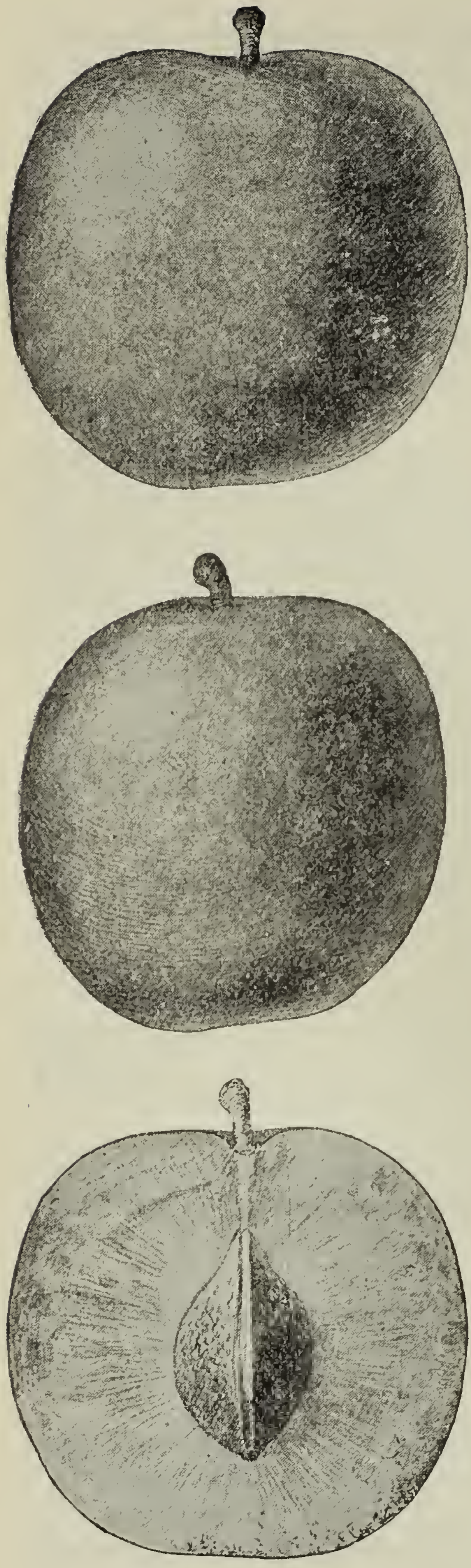
Copper (French).—A late plum, very productive and profitable, ripening last of September, frequently hanging into October; fruit medium, dark copper color and valuable for preserving. Tree a poor grower; hence, can rarely be found in hands of nurserymen. It should be worked on some strong growing sort. A fine shipper and usually sells at good prices. [Fruit globular, copper-purple with thin bloom. Valuable because of extreme lateness. —L. H. B.]

Cruger's Scarlet.—A variety that several years since was grown largely in the vicinity of Geneva. The name indicates the color, which makes it attractive when grown exposed to the sun, but the size and quality being against it both for market and family use, it has been supplanted by others of more value.

* *Curlew.*—An enormous bearer of attractive large, deep blue fruit, ripening just before the middle of August; but the foliage drops early, preventing at times a fair maturity of the crop and unfitting the tree to withstand the severity of our winters.

* *Czar.*—Origin, England. A large, early, purple plum, rich and good; ripening about July 25th; very productive. Defective in foliage; though fine in quality of fruit, it is of no value. Its extreme earliness would make it valuable were it more hardy.

**Diamond* (Fig. 40, VI.).—Large, dark purple, with a beautiful bloom which renders it very attractive in appearance and sought for on the markets. Tree very productive, hardy and one of the best of English introductions, and, in my opinion, when better known, will be highly regarded as an orchard variety.



41.—*Empire plum.*

Duane's Purple.—Fruit very large, oblong; skin reddish purple; flesh yellowish, juicy and sweet, quality good; desirable for the garden or home use, but ripens with too many others to have market value, being at its best between 8th and 15th of August here. This is one of the old varieties that is rarely heard of to-day.

**Early Rivers.*—Of English origin. Medium size, oval; purple; rich and juicy; perfect free stone; ripening last of July. Very productive, but the tree has been very tender and for this reason has been discarded, and I believe would be of no value to anyone.

Empire (Fig. 41).—Originated in Cortland county, in this state, and at one time sent out under the name of the Rood plum. Oval; color dark purple; large; quality good; tree hardy, productive and vigorous. Fruit ripening about September 5th to 10th. A variety that may become a popular orchard sort. See Shipper's Pride.

**Farleigh Damson.*—Fruit dark purple, a little smaller than Shropshire (which see), intensely productive and one of the most hardy of all plums in bud and wood. It is valuable as an orchard tree and when better known will be in demand.

Field.—A seedling of Bradshaw; ripening ten days earlier, of same large size and color, except that it is darker and not so attractive. The fact, however, that it comes upon the market earlier adds to its value. It originated in Schoharie County, New York. It has an excellent foliage and ripens an extremely hard bone-like wood well calculated to withstand injury from severe cold. It sets a heavy crop in alternate years.

**French Damson* (Fig. 41, I.).—One of the largest of the Damson family.

tardy in coming into bearing, but can be regarded as a desirable orchard variety.

Union Purple.—See Reagles' Union Purple.

* *Victoria.*—Fruit large ; oval ; reddish upon a yellow ground. An abundant bearer, but foliage very defective, frequently leaving the tree with a mass of unripened fruit, which, in a warm, moist season, is apt to decay badly. With me this variety has been a complete failure.

Warner's Late Red.—A late, small, red plum sent to me several years since from Schoharie County, N. Y. Tree very hardy and prolific, but fruit lacking in such essentials as would be regarded desirable either for home use or market.

47.—*Weedsport Prune.*

Washington.—One of the largest of all plums, of fine quality, skin yellow ; has an excellent foliage. Fruit ripens middle to last of August at Geneva. Tree vigorous and hardy, desirable in a family collection, but can hardly be said to have value as a market fruit.

Weedsport Prune (Fig. 47).—One of the many German prunes, the tree of which is so poor a grower that it will be grown by few in the nursery, and the fruit differs little from several other strains. Much esteemed about Weedsport, N. Y.

Yellow Egg.—A variety that has been disseminated under several other names, but more frequently called for as Magnum Bonum. Very popular because of its beauty and size and value for canning purposes. Skin yellow with a bloom and a deep golden color when fully mature. The tree is on

of the most hardy of the plum family and where this is an essential, it should be more generally planted, provided the soil is inclined to be heavy. On some of the light soils of Michigan we have known of its dropping the fruit badly before mature. Its large size and fine qualities for canning make a demand for this purpose among those engaged in this industry which would warrant its cultivation more largely. It ripens about the middle of August, is of low quality and in no sense a desirable fruit to eat from the hand.

Yellow Gage is a general name for a class of yellow plums, of which Peter's Yellow Gage is the best for western New York.

Japanese Plums.

Abundance.—A variety of the Japanese plum which I have now been fruiting for eight or nine years. I regard it as one of the best of several of the family that I have tested and so well known as to need no description. Quality good and productive ; tree hardy and vigorous, but in no sense equal in my estimation to the next.

Burbank.—A variety sent out by Mr. Luther Burbank, of Santa Rosa, California, and well described in Bulletin 106 of the Cornell Experiment Station. The tree is very hardy and vigorous, but the most sprawling in its habits of growth of any plum I have ever cultivated. As regards productiveness, it is unequaled by any plum I have ever fruited. To produce the finest fruit heavy thinning should be practiced. The quality is excellent and it is destined to become one of the most popular of all plums for canning, while its attractive color, good quality and shipping properties will cause it to be sought for as a market variety. It ripens ten days to two weeks later than Abundance. I have had it in fine condition the last week in August and early in September.

Kelsey.—This variety has winter-killed to such an extent that I abandoned any effort to fruit it and am sure if the variety obtained was true to name that it cannot be grown as an orchard tree at this place. [We still hear of the Kelsey being fruited in New York, but in every case which we have investigated some other Japanese variety has been misnamed the Kelsey. The farthest north which I have ever known the true Kelsey to fruit is southern Delaware.—L. H. B.]

Ogon.—Medium to large ; color lemon yellow ; flesh firm and a good shipper ; perfect free-stone ; quality poor ; inclined to drop badly before mature, and is only a fair producer. I see no reason why it should be planted in the commercial orchard, but is a good canner. Have had it in fruit for several years.

True Sweet Botan.—Received from J. C. Normand, of Marksville, Louisiana. It closely resembles the Abundance in wood and fruit, and yet it seems inclined to ripen a few days earlier ; of better quality and apt to take on a brighter red color ; hardy and productive.

Willard.—This variety, with several others, was obtained in a lot of cions obtained in California several years since and in which I became specially

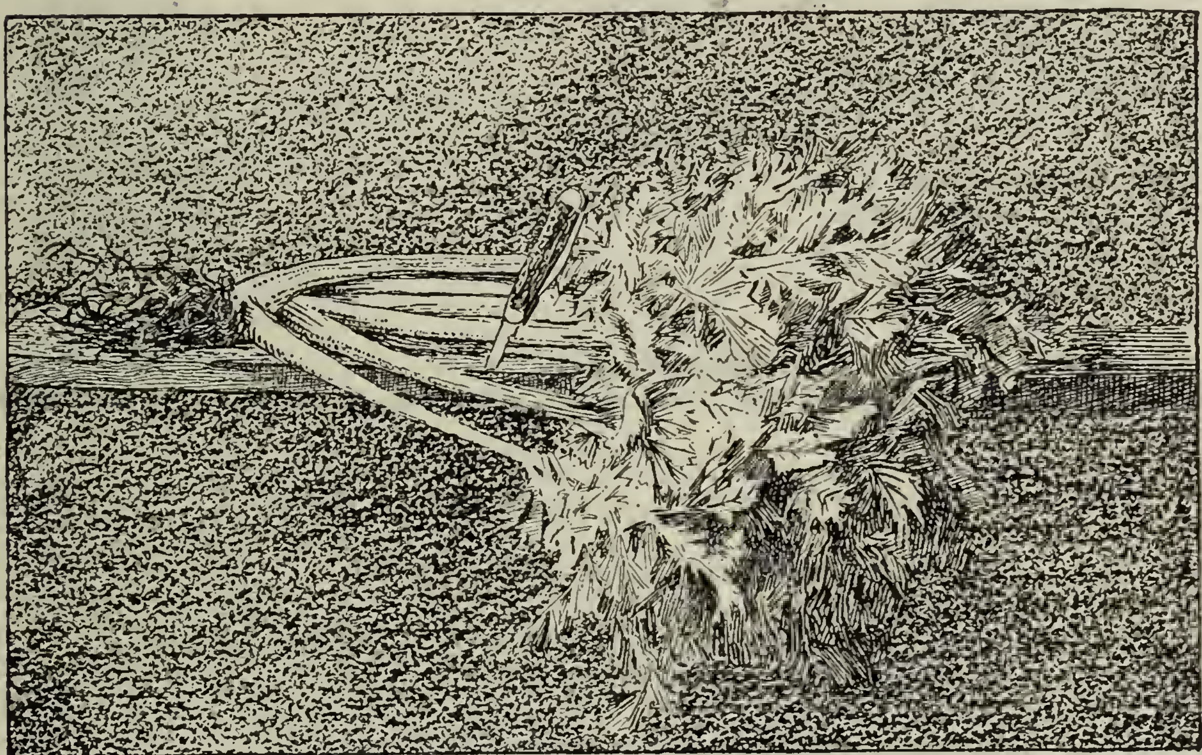
interested because of its vigorous habit and hardiness. Size medium ; color red and attractive ; productive ; very early ; frequently ripening by 15th to 20th of July, and when picked early will keep a long time in good condition with no disposition to decay. Quality poor ; indeed, as compared with others, I regard it as inferior.

Yellow Japan.—This variety was obtained of Mr. Normand, and I understand has also been disseminated under the name of the Chase. Fruit not quite equal to Burbank in point of size as grown in close proximity on my grounds. Color of skin not quite so dark. Quality good, habit of growth upright, foliage not so strong and in my opinion the tree might not endure as low a temperature without injury as the Burbank. It ripens considerably later and is more variable in its habits. The fruit has been much larger and of better quality and color some seasons than others, upon the same trees ; hence, I have been led to infer that it is scarcely as reliable as Burbank. [This is the Chase of my Bulletin 106, and that name should be preferred.—L. H. B.].

The following is a list of others of the Japan family, growing for test purposes, some of which have borne a little fruit, but not sufficient to warrant an expression as to their merits : Satsuma, Berger, Wickson, Red June, Normand, Shiro Smomo, October Purple. The last received from Luther Burbank from whom also sample fruit was had, which was fine in appearance and of excellent quality, and should this variety develop quality and productiveness of a satisfactory nature here, I believe it will be valuable.

Bulletin 132. March, 1897.
Cornell University Agricultural Experiment Station.
ITHACA, N. Y.
Botanical and Horticultural Divisions.

NOTES UPON CELERY.



By B. M. DUGGAR and L. H. BAILEY.

PUBLISHED BY THE UNIVERSITY,
ITHACA, N. Y.
1897.

ORGANIZATION.

BOARD OF CONTROL:

THE TRUSTEES OF THE UNIVERSITY.

STATION COUNCIL.

President, JACOB GOULD SCHURMAN.

Hon. A. D. WHITE,	Trustee of the University.
Hon. B. F. TRACY,	President State Agricultural Society.
Professor I. P. ROBERTS,	Agriculture.
Professor G. C. CALDWELL,	Chemistry.
Professor JAMES LAW,	Veterinary Science.
Professor J. H. COMSTOCK,	Entomology.
Professor L. H. BAILEY,	Horticulture.
Professor H. H. WING,	Dairy Husbandry.
Professor G. F. ATKINSON,	Botany.

OFFICERS OF THE STATION.

I. P. ROBERTS,	Director.
E. L. WILLIAMS,	Treasurer.
EDWARD A. BUTLER,	Clerk.

ASSISTANTS.

M. V. SLINGERLAND,	Entomology.
G. W. CAVANAUGH,	Chemistry.
L. A. CLINTON,	Agriculture.
B. M. DUGGAR,	Cryptogamic Botany.

Office of the Director, 20 Morrill Hall.
The regular bulletins of the Station are sent free to all who request them.

BULLETINS OF 1897.

124. The Pistol-Case-Bearer in Western New York.
125. A Disease of Currant Canes.
126. The Currant-Stem Girdler and The Raspberry-Cane Maggot.
127. A Second Account of Sweet Peas.
128. A Talk About Dahlias.
129. How to Conduct Field Experiments with Fertilizers.
130. Potato Culture.
131. Notes upon Plums for western New York.
132. Notes upon Celery.

Cornell University, Ithaca, N. Y., March 30, 1897.

Honorable Commissioner of Agriculture, Albany.

Sir: The things which celery growers in western New York chiefly want to know is what to do for blight and how to fertilize the land. We have tried to find out. The attempt is submitted for publication under Chapter 437 of the laws of 1896.

L. H. Bailey.

CONTENTS.

56.—*Interior view of old-style storage house, shown in Fig. 54. Celery mostly removed.*

NOTES UPON CELERY.

I. TWO DESTRUCTIVE CELERY BLIGHTS.

Introductory.

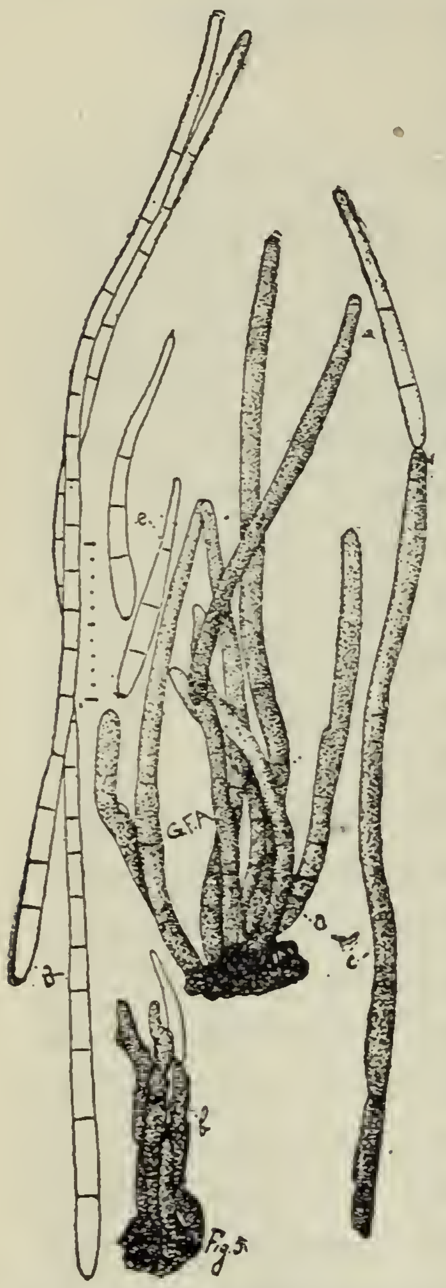
The celery industry in New York has attained a rapid development during the past ten or twelve years. It was only a few years earlier that this plant became so extensively cultivated in the favorable region about Kalamazoo, Mich. At the latter place the conditions are such as to form an environment peculiarly salubrious for celery, and the disease question appears not to have forced itself so prominently upon the attention of growers. In other widespread areas, celery is subject to several blights and spots which greatly affect the marketable value of the product. In the growth of this plant there is no little expenditure of labor, and any cause operating to reduce the price of each heart a few cents means the obliteration of the profits of the grower. There is no doubt that with favorable conditions and skillful management celery is a paying crop, but two fungous diseases, especially prevalent during the past season, threaten the profits of many. Practically, work upon these diseases has just begun, and if at the outset there is given simply a clear exposition of what these diseases are, and their effects upon the plant, it is hoped to secure the coöperation of those interested; and, in future, work will be undertaken toward definite measures of relief. In this bulletin a general knowledge of the subject will be summarized, and special attention is called to the matter of storage cellars and to the disease last season so prevalent therein.

A. Early Blight of Celery.

General Discussion.

During the latter part of July of the past season, L. A. Clinton called my attention to the destructive effect of a celery disease on the truck lands of R. W. Parr, Ithaca. The plants then badly

affected were in an advanced state of growth. Many of the lower leaves were brown and wilted, while the disease seemed to spread rapidly to the younger leaves as they unfolded in freshness and vigor. The spots on the vigorous blades were characteristic of the disease popularly known as "celery blight," and a microscopic examination confirmed this, showing the causal fungus to be *Cercospora Apii.* This is one of the first celery diseases to make its appearance either in the seed-bed or in the field. It is a well known pest in Europe, and in this country it seems to have received spasmodic attention for nearly fifteen years. Beginning on the outermost green leaves, it appears in spots more or less circular, grayish-green at first, and becoming brown and ashen. In the early stages of the disease there is a well defined spot with slightly raised border; but when the spots become numerous on a leaf, the latter begins to turn yellow, and subsequently the fungus develops abundantly its fruiting growth in indefinite areas, thus giving the characteristic ashen spots of indiscriminate form. The filamentous vegetative organs of this fungus, like most parasitic fungi, grow within the tissues of the leaf, and soon minute fertile filaments, or hyphæ, are protruded in slight fascicles through the pores, or stomates, of the leaf. These fertile hyphæ (or fruiting filaments) as seen under the microscope are illustrated in Figure 48, *a*, *b*, and *c**; and here it is also seen that these hyphæ bear hyaline reproductive bodies, the spores, or conidia, *e* and *d*. Falling upon other leaves with suitable moisture, these conidia germinate by the protrusion of delicate thread-like tubes, and these tubes effect an entrance



48.—*Microscopic characters of the early blight.*

*This figure was drawn by Professor Geo. F. Atkinson, and used by him in Bulletin 49 of this Station.

through the epidermis of the leaf to the tissues within, where they spread and again cause the death of the affected parts, and consequently the characteristic spots. Each hypha bears more than a single conidium, and the scars or knees shown in the figure are the points at which successive conidia were borne. The conidia retain their vitality for some time, and it is feared that they may be able quite generally to pass the winter without injury.

Considerable confusion exists regarding the nature of the season during which this disease is most prevalent. It has been reported most abundant during the hot, dry periods, and also most injurious during the warm "muggy" days.* In my own experience heat is an important factor, but moisture does not necessarily give the celery plant the mastery. In hot dry weather the vigor of the plant is reduced; and, with heavy dews at night, the action of the fungus is marked, especially on the lower leaves. With a wet soil and muggy days I have noted a rapid spread of the fungus, and it is then that the disease will spread over large areas of wilted or affected leaves. In a report† of the Division of Vegetable Pathology, it is stated that shade is of great importance; that where the soil is cool and moist, and the air humid, as at Kalamazoo, Mich., the disease is said to be unknown. In this connection the only observations I was able to make were upon small areas in well drained, shaded, garden lots; and in such locations the fungus was not abundant. This disease disappears with the cool nights of autumn, and it may be followed by the other blight discussed in this bulletin. Because this celery disease does not usually appear late in the season, and in order to distinguish it from others, I have spoken of it as the early blight of celery.

Remedies.

The use of fungicides for the prevention of the early blight has been attempted with varying success, but there is still lacking much definite information about the use of these materials which will necessitate some extended experiments during the ensuing season.

---

*Report U. S. Dept. Agriculture, 1886, p. 117.

†Report U. S. Dept. Agriculture, 1888, p. 398.

Salt, lime, hyposulfite of soda, potassium sulfide, etc., have been used unsuccessfully.

Experiments conducted by the Division of Vegetable Pathology at Washington indicate that shading the plants by means of screens is most effective; but this seems wholly impracticable.

The most pronounced results thus far with fungicides are in favor of the ammoniacal copper carbonate solution, although in one region sulfur has seemed more successful. At the New Jersey Experiment Station in 1891, Halsted found that the yield of marketable celery from a row treated with the copper compound was nearly double that of an untreated adjacent row; and, moreover, application of the fungicide was not made until the celery was already badly blighted. At the Connecticut (New Haven) Experiment Station, Sturgis recommends the use of dry sulfur at the rate of 2 lbs. for 1,200 plants.

It is necessary to add a few experiments made in Ithaca during the past season, in the field where the early blight was first observed. As before mentioned, most of this celery was in an advanced stage of growth, and badly diseased; but it was thought that if the fungus could be checked until lifting time, much good might result, and at least a practical demonstration of the use of fungicides for celery would have been made for the Ithaca growers. Sulfur at the rate of 1 lb. to 1,000 plants and a standard solution* of ammoniacal copper carbonate were used. An application of one of these fungicides was made to each of two plats of celery, and a larger plat untreated reserved as check, the treatment being given on July 28, an exceedingly hot day. The following week there were alternate rains and scorching suns, and at the end of this time the plants sprayed with copper carbonate appeared slightly scalded. There was then hot, dry weather for a week or more, and on August 15 there was marked improvement in the rows sprayed with the copper compound,—so much so that it might be detected at some distance. The rows dusted with sulfur showed some improvement, but less than the sprayed plat. On

---

*A formula often used is as follows:

Copper carbonate	8 ozs.
Ammonia water (26°)	3 pints.
Water	45 gals.

August 15 a second application was made as before, except that a weaker solution* of the copper carbonate was used. A heavy rain followed in a short time, and little result could be anticipated from this application. I was then necessarily absent from Ithaca for a month, and further applications were not made. Thus the work was left in rather indefinite shape to await earlier experimentation another season. The results at least suggest that carbonate of copper may be used to advantage. At the time of setting, young plants (leaves only) might be dipped in a weak solution of this fungicide, and subsequently the growing plants sprayed at intervals of two weeks with a solution of the same strength. Any of the spraying apparatus used for potatoes would suffice for this work. Growers should be extremely careful not to set plants which are in any way spotted in the seed bed; and if the sets are purchased, use none in a lot showing any indication of the disease.

The fact that the spores of the fungus have been found to germinate after passing the winter on the dead leaves† of the previous season will suggest to progressive growers the need of destroying all refuse matter and diseased material. Bits of diseased material will remain, however, and this alone indicates that rotation is a good thing where it is practicable. Again, the fungus spreads rapidly upon wilted plants, especially in muggy weather, so that care should be taken to collect and destroy the product of suckering. A disease of the common wild parsnip so closely resembles this celery blight that many botanists consider them forms of the same disease; so it may be well to rid the borders and fence rows of the wild parsnips.

Artificial Cultures of the Fungus.

The length of the fruiting hyphae and conidia are largely dependent upon the amount of moisture in which they are developed, and probably somewhat inversely upon the vigor of the leaf. On leaves placed in a moist chamber the condition is much as represented in Figure 48, *c* and *d* (pro-

* This formula consisted of

Copper carbonate	6 ozs.
Ammonia water (26°)	2 pints.
Water	45 gals.

† Report U. S. Dept. Agriculture, 1888, p. 399.

duced on wilted leaves in a wet season); while *b* and *e* show the same fungus under normal conditions. I have experienced no difficulty in germinating the fungus on plates of agar, and in securing pure cultures in tubes of sterile bean stems or of petioles of celery. In this condition the fruiting hyphae are often ultimately more than a millimeter in length. At first conidia are regularly produced, leaving the accustomed geniculations; and these conidia vary in length from some exceedingly short to others measuring 250 μ. After the hyphae have attained considerable length no further conidia are produced; and, instead, the spore-like branches which arise remain attached, and appear as true branches of fertile hyphae. Figure 49 (Leitz ocular 1, objective 4) illustrates the character of growth on bean stems. I neglected to make a photograph of a good petri-dish isolation culture until it was badly contaminated with bacteria; but Fig. 50 serves to show the nature of the growth on agar. The colonies are large, circular, at first olivaceous, and not readily separable from the agar. Later a grayish-white aërial growth of cottony mycelium appears, interspersed with which are the long fruiting hyphae. In general, growth in artificial cultures is characteristic, both on agar and on bean stems, differing materially from that of half a dozen *Cercosporæ* cultivated during the past summer. No perfect stage of this fungus has been secured; but every effort is being made to ascertain if there is an intervening perfect form. As yet, I have not been able to secure cultures of *Cercosporæ* on hosts closely related to the celery.

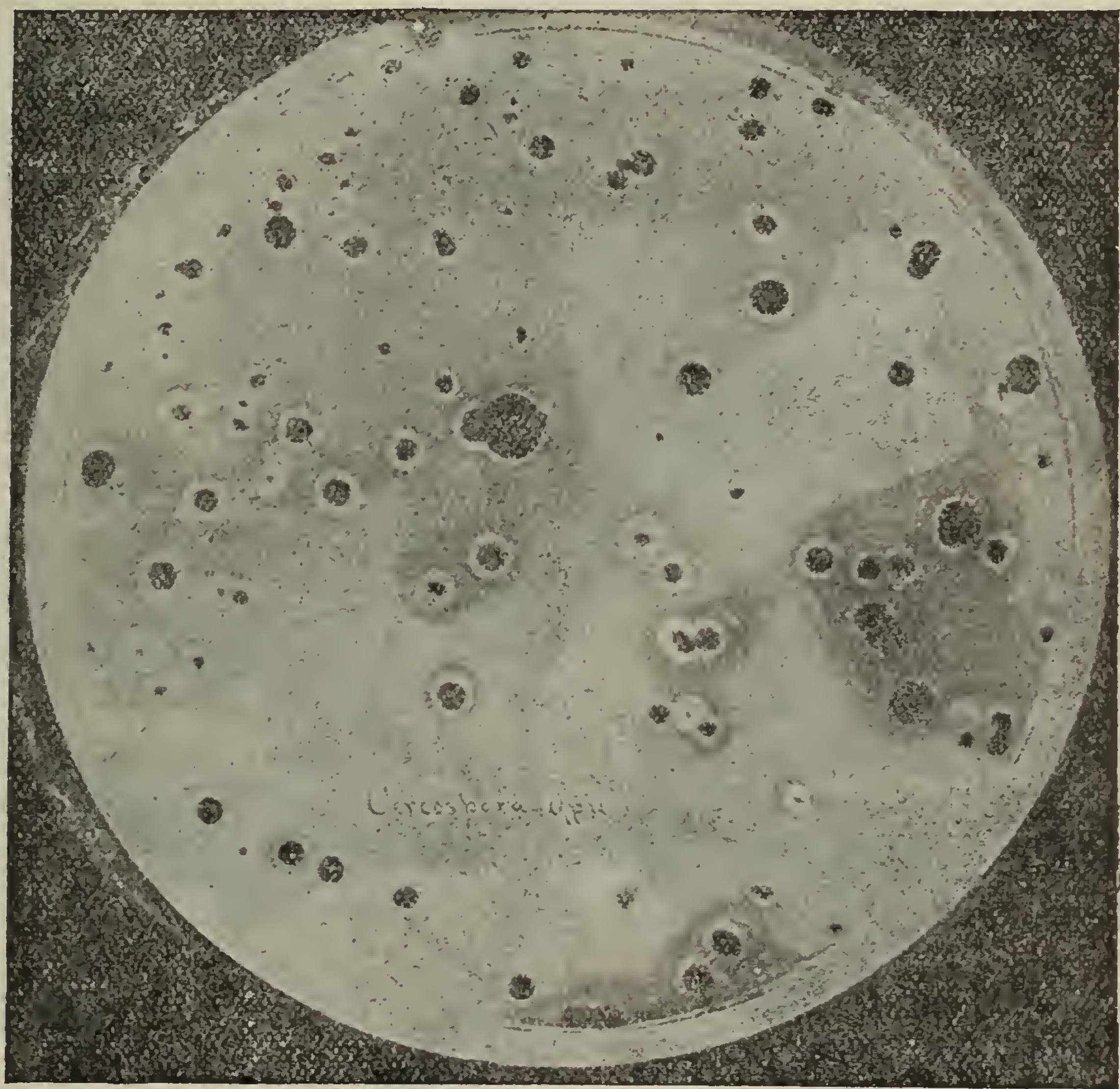
49.—*Hyphae of the Cercospora, when grown on bean stems.*

B. LATE BLIGHT OF CELERY.

General Discussion.

At the same time that the early blight was abundant on the Ithaca flats, a different disease was found in a garden not far distant. The latter disease had then appeared on a few leaves only. In general appearance it might easily have been mistaken for the early blight, although it is distinguished from the latter by more irregular spots, which are of a tawny color. Under a hand lens, minute, black, fruit bodies, or pycnidia, could be seen on either

side of the leaf; and the operative fungus was found to be one called *Septoria Petroselini*, Var. *Apii*. The form on celery is a disease which has been known to mycologists in this country only about six years, and with favorable conditions for its spread, it has proved to be a most destructive celery disease. In the garden mentioned this fungus did not spread rapidly during the



50.—*Growth of the Cercospora in agar.*

summer, and it was not until early autumn that much harm seemed to have resulted from its action. With a slight attack the irregular spots are well defined; but with conditions more favorable for the disease the fungus may spread rapidly to the whole surface of the leaflets (illustrated in Figure 51), and even to the petioles, causing a complete wilting of affected leaves. The minute, black, fruit bodies, or pycnidia, are then abundant on

all parts of the leaf, and by careful observation they may be seen with the naked eye.

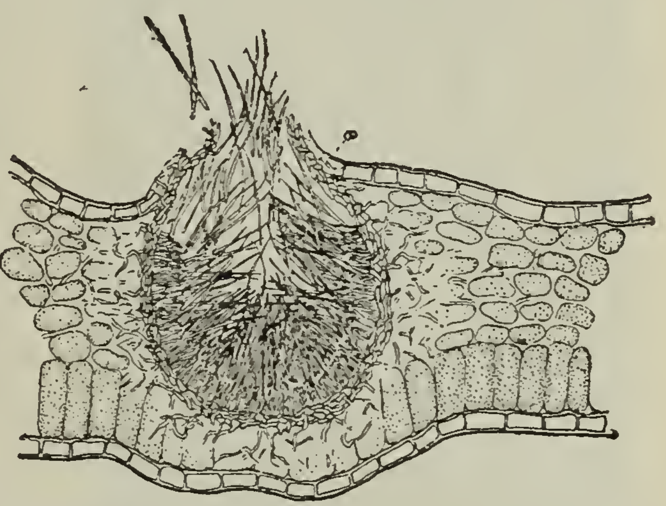
A section of a leaf through one of these minute pycnidia is shown in Figure 52. At *a* is shown a cross section of the more or less spherical fruit body. It is deeply immersed in the tissues of the leaf, and the walls are stout and appressed. From these walls arise a forest-like mass of minute filaments, or basidia,

51—*Spots of late blight on a celery leaf.*

bearing the needle-shaped spores, or reproductive bodies of the fungus. When ripe, these spores are doubtless expelled through the mouth of the pycnidium by means of absorbed water, and then they are readily scattered by wind and rain for the immediate dissemination of the fungus. The spores readily germinate, giving rise to the delicate tube-like filaments, which enter the tissues of the leaf as mentioned for the *Cercospora*.

The disease is active in the field until the last plants are lifted; and, as mentioned before, I have found it following the early blight during the cooler weather. However, as will be seen later, the late blight does not confine its ravages to the field, but extends its destructive action to the storage coop, or cellar, and as the disease has already been termed a blight, it seems well to speak of it as the "late blight." There is already another fungus called the "leaf-spot of celery."

From later observations it seems that the late blight was the most injurious celery fungus during the past season, but it was not so destructive at Ithaca. Few experiments have as yet been made with the use of fungicides upon it, but it has been recommended by the New York (State) Station at Geneva to spray young plants with Bordeaux mixture. With older plants it would be better to use the ammoniacal copper carbonate, or it may prove as well to use the latter throughout. The same caution relative to the use of healthy seedlings will apply as for the early blight, and in this case it is especially necessary to begin early. Further remedial suggestions will be made later.



52.—*Section of a pycnidium, or fruit-body, of the late blight.*

Late Blight in the Storage House.

It is to be remembered that the late blight may yet be active when the last lot of celery is transferred to the coop, or root house, as these storage cellars are variously termed. This brings us to an important feature of the celery disease question, and one which, apparently, has hitherto received no attention. Again my attention was first called to this matter on the premises of R. W. Parr, Ithaca, by an examination made late in December of celery stored both in a cellar and in a root house. In the cellar where the trouble was greatest, the temperature was manifestly higher than might be desired. The first effect of the disease is quite the same

as that seen in the garden in severe cases. The outer green leaves are the first to wilt, and on these the black dots, representing the fruiting bodies of the fungus, are scattered indiscriminately.

53.—*Celery plant, from a cellar, affected with late blight.*

Soon the fungus spreads to the younger and blanching central leaves, wilting and discoloring these wherever a foothold is secured. Fig. 53 is a photograph of a diseased plant from this cellar, showing the wilted and blackened appearance of the leaves. The plant was so much wilted that the photograph was necessarily taken by suspending the plant top downward. In the root house the temperature was evidently much lower than in the cellar, but even in the former the disease was destructive. As far as marketable plants were concerned, the whole stored product was greatly reduced, and I could see no hope of profit on the necessary outlay.

As the late blight was proving so destructive in Ithaca, where celery is grown on a small scale only, it was thought well to visit some other truck regions of the state where celery gardens are more abundant. Accordingly, early in January a visit was made to South Lima and Irondequoit with the hope of securing, even at this late date, additional and valuable data relative to the injuries from this disease in the storage cellar.

On making a survey of the root houses at South Lima, I found the amount of loss sustained from the late blight far greater than

had been anticipated. A large portion of the stored product had been marketed early on account of the prevalence of the disease; and of the celery remaining in the coops at this season, it seems to me a fair estimate to say that not more than one-third of it was salable. The celery growers of this place reported that they were not familiar with the blight in previous years, and during the past season it first came to their attention during September, when the plants were lifted for storage. At this time the leaves were somewhat spotted by the disease. This was evident on examining the older and formerly green leaves of the stored product; for the tell-tale spots, produced only when the celery is in a normal growing condition, were abundantly manifest. It was supposed by the growers that the warm weather following the first early cold spell had much to do with the trouble. As a matter of fact, there was much warm weather after most of the celery had been removed to the cellar. From the state meteorological records it will be seen that the month of September was one degree colder than normal, October two and one-half degree below the normal, and for November the temperature was nearly five degrees (4.7°) warmer than the normal temperature as thus far determined. This rise of temperature was undoubtedly a serious thing, for warmth is an important factor in encouraging the spread of the fungus. The celery plants being arranged close together in the root house, the fungus spreads not only, it may be, from its former circumscribed spot areas to all parts of the leaf, but to neighboring more healthy leaves; so that on the surface there is a dense stratum of the diseased material, and as the young blanched leaves push upward they in turn come in direct contact with the germs of disease. When once decay begins, bacteria, yeasts, and moulds readily effect rapid rotting of parts not easily affected by the blight itself. This was especially true where moisture was greatest. It is only to be regretted that we did not know earlier of the prevalence of the blight in the storage houses; for its effects might then have been closely followed, and a knowledge of the exact conditions which accelerate the destructiveness of the disease could now be more accurately applied.

Nearly all of the root houses of South Lima are of the old style,—essentially a roof of boards upon which is thrown straw,

earth and manure, as represented in Fig. 56; but a brief discussion of specific styles of root houses will be considered later.

At Irondequoit, near Rochester, there are located some of the largest celery gardens of the state. At this place I found the condition of the celery a great improvement over that at South Lima. Nevertheless, considerable loss had resulted, and I was confirmed in the belief that the late blight was generally quite prevalent in the field during the past season. Here the disease had extended to the storage house product to an injurious extent, but there was evidently some important factor to account for its lessened effect. At Irondequoit there is a well drained gravelly soil, with clay subsoil, and it was noticeable that in the root-houses of this region there was much less moisture than in those of South Lima. It was this difference, in fact, which readily suggested that care should be taken with regard to the location of coops, especially for the contingency of unfavorable seasons.

Why the South Lima root houses contain more moisture, and hence were more severely visited, it is necessary to consider the surroundings. It is only within the past few years that celery has been grown to any extent in this region. Previous to this time there were about six hundred or more acres of bog land north and south of the Erie Railroad, which could have been purchased for almost nothing. Drainage of this area was since authorized, and it is this drained bog land which is now so valuable for the growth of celery. It is a true peaty soil, which burns very readily. This deposit is said to vary to about twenty feet or more in depth, and it is underlaid by a slight gravelly deposit, and then an impervious clay. Surrounded by high land on nearly all sides, this bog land lies as a natural basin in a glaciated region. Water seems to drain freely into this gravelly substratum and it is prevented from sinking further on account of the impervious clay. The peaty stratum above absorbs the water freely, and on account of its great capillary action it is capable of constantly pumping up the water from below, thus furnishing a soil in which celery grows luxuriantly. On account of this moisture, however, extra attention should be given to the disease question. With root houses located immediately upon such bog land, or upon slightly higher ground of approximately the same texture,

moisture is constantly pumped into the root house; and the necessarily inferior ventilation of such houses render them peculiarly favorable for the growth of the fungus, provided the temperature is sufficiently high. Good ventilation seems to be an important preventive factor, and the best evidence of this is afforded by the observation that the blight is less injurious along the central gangways of the cellars. On the basis of the location, however, it seems possible easily to account for the drier houses and better stored celery at Irondequoit; but it must be remembered that the past season was unfavorable everywhere. The celery which remained in the field longest was least subject to the abnormal conditions, and consequently less affected by the disease.

I also visited the celery gardens of Horseheads, near Elmira, where considerable loss had been reported. There the trench or banking system is still in vogue, and on account of the freezing weather, I could see but little of the stored product; yet those who attempted the trench system at Irondequoit during the past season were very unsuccessful, and on the whole it seems unwise to recommend it for protracted storage.

Remedies.

Although it has not yet been possible to conduct any remedial experiments, certain practical remedies are readily suggested by the conditions. A great desideratum is to bring to the root house a minimum amount of the disease. To this end, plants in the field should be sprayed regularly to prevent its appearance there. Any badly affected leaves should be stripped away before consigning to the coop, and it seems highly probable that fungicides may be used most effectively with the stored product. Without a great amount of extra labor, the leafy portion of the plants could be dipped in a weak solution of the ammoniacal copper carbonate before being stored, and as there is then no chance of its being washed off by rain, this measure should prove effective. The carbonate solution is mentioned because the only objection that might be urged against it is the slight deposit of copper. However, as most of the original green leaves are stripped off in the

trimmings, and as the plants are subsequently thoroughly washed, it seems that this efficient fungicide might be used without encountering the enmity of the most fastidious purchaser.

As previously mentioned, it is not known how the fungus causing this disease passes the winter, but it is quite likely that all diseased leaves and culls, both from the field and root house, are certain sources of contamination another year. It is doubtless impossible to destroy all such diseased material, but the more that is destroyed the less the probability of abundant reappearance; and if the disease is to be fought effectively, it must be fought in every stage.

Special Characters of the Fungus, and Artificial Cultures.

According to Halsted* the first mention of a *Septoria* on celery is by Briosi and Cavara†, in 1890. Here the fungus is given under the name mentioned above (*Septoria Petroselini* Desm., Var. *Apii* B. & C.) ‡. By Halsted, Chester, and Ellis this fungus has been compared with the species distributed by Briosi and Cavara, and they see no reason why our American form is not the same. There seems to be some doubt regarding the character of the spores. Halsted figures them uniformly septate, while Chester apparently saw no septa, and he describes them as "apparently non-septate, or septulate, guttulate." I have carefully examined a number of specimens from the field and from artificial cultures. Invariably mature spores are septate; but often the septa are not visible without the use of stains.

The spores germinate readily in agar, so that isolation cultures may be made in petri dishes. From such cultures, transfers to tubes of sterile bean stems have given good growths of the organism in a pure form. These cultures have given mature pycnidia in a few weeks. The perithecia are then formed superficially upon the bean stems, and formed of loosely woven, brown hyphae. Humphrey § has suggested that the *Septoria* is connected with the *Cercospora* as pleomorphic forms of the same species. His suggestions, I believe, are based mainly upon gradations in spot characters. Chester was never able to find both fungi in the same spot, although both were sometimes found upon the same leaf. My cultures indicate as clearly as possible thus far that these two fungi have no genetic connection, if we may judge at all from growth characters. Under similar conditions, not only has the

*Report, New Jersey Ag'l. Exp. Sta., 1891, p. 256.

† Funghi Parasitti Fascecola, VI. No. 144.

‡ *Note.* The only additional foreign mention yet encountered of a celery disease due to a *Septoria* is a short article by Sorauer on "Die Fleckenkrankheit des Sellerie," in Zeitschrift für Pflanzenkrankheiten, VI. (1896), H. 3, p. 191. The spores of this *Septoria* are described as non-vacuolate, non-septate.

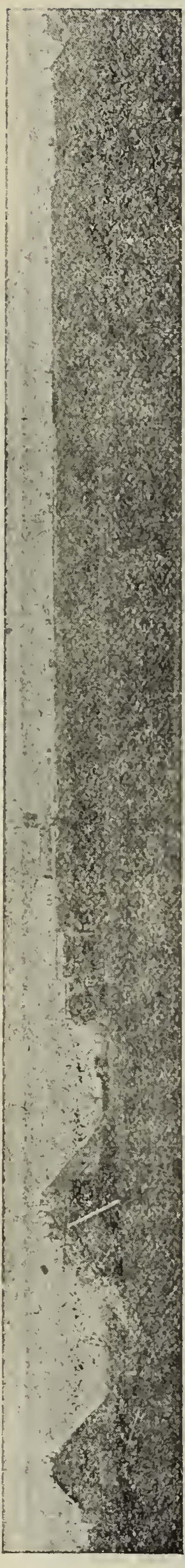
§ Report Mass. Agl. Exp. Sta., 1891, p. 231.

Cercospora produced only *Cercospora*, and the *Septoria* only *Septoria*, but the general character of the mycelium both in petri dishes and on bean stems is essentially distinct. Either or both of these fungi may have a perfect form, and these I am attempting to encourage; but I think it unnecessary to hold that the two fungi will be found to have the same perfect form. Should it be so, this fact would be of importance relative to the appearance of the disease in the root houses or storage cellars.

54.—*View of celery houses at South Lima.*

C. REMARKS ABOUT THE CONSTRUCTION OF STORAGE HOUSES.

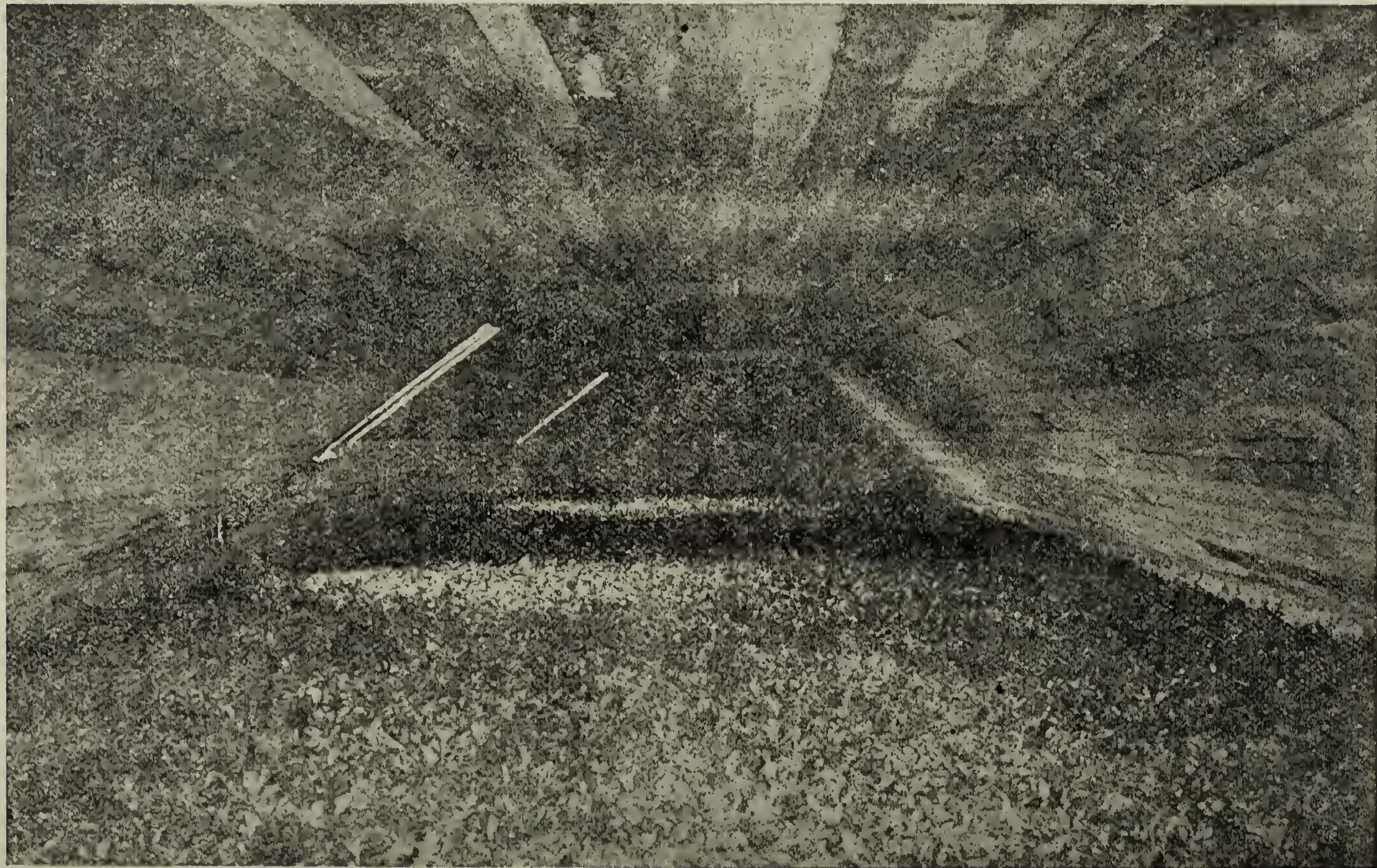
The growing demand for celery during the late winter months has recently brought about considerable improvement in the construction of storage houses; and as has been suggested, this matter is intimately associated with the disease question. The original type of root house, which I have not seen in New York, was essentially a rail coop. Upon the rails, straw and earth, or manure, were placed in sufficient quantity to keep out cold and moisture. Trade demands soon necessitated the form seen in Figs. 54, 55, 56, for the storage of celery. This form is well known, and the construction of this is easily made out with the aid of Fig. 56, which is an interior view. These houses are usually provided with double doors at both ends, two or more



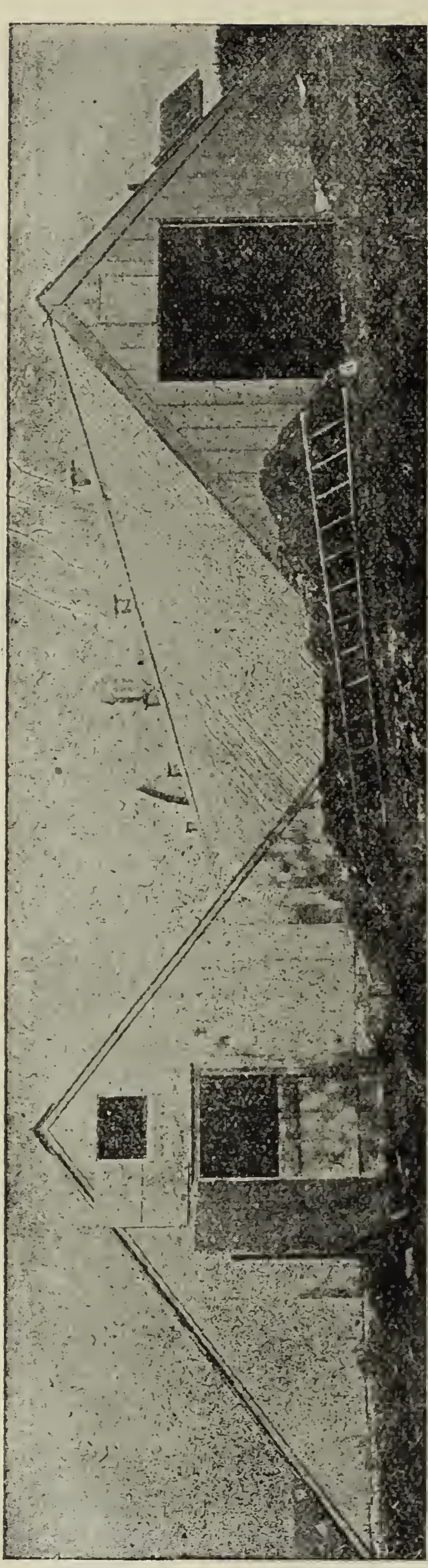
55.—*South view of the earth-covered houses of South Lima.*

windows, and with a number of ventilators. The greatest difficulty with these houses is that they rot down rapidly, and they may give some trouble with moisture. They are inexpensive, however, and the cost of construction is only about $125. It may be suggested that in constructing root houses or storage houses of any kind the fundamental principles involved relative to the purpose of the structure should be constantly considered. To continue its vitality, succulence, and crispness, celery must continue in the storage house a very slow growth,—a growth sufficient to establish the roots in the soil and to complete the development of the inner leaves. Thorough freezing is fatal, but the lowest temperature at which freezing will not take place is most desirable. Not only does this temperature hold the plant in the desired condition of greatly suspended activities, but it renders next to impossible the growth of injurious fungi which would speedily wilt and rot it. In order, then, to approach the temperature sought, the house should be so snugly constructed as to provide against freezing. Again, it should be so provided with ventilating appliances that at any time advantage might be taken of any cold intervals to rapidly and effectually chill the house, after which it might be securely closed for a warmer period; and with this enclosed lower temperature remain for a time at a point more nearly that desired.

In Figs. 57 and 58 is shown one of the most improved root houses which I have seen in operation, and the photograph here reproduced was taken on the premises of Abram Franke, Irondequoit. With the usual excavation of eighteen inches or two feet, this structure has a brick foundation, and the roof is well provided



58.—*Interior view of one of the houses shown in Fig. 57.* *See page 216.*



57.—*Improved celery houses at Irondequoit.*

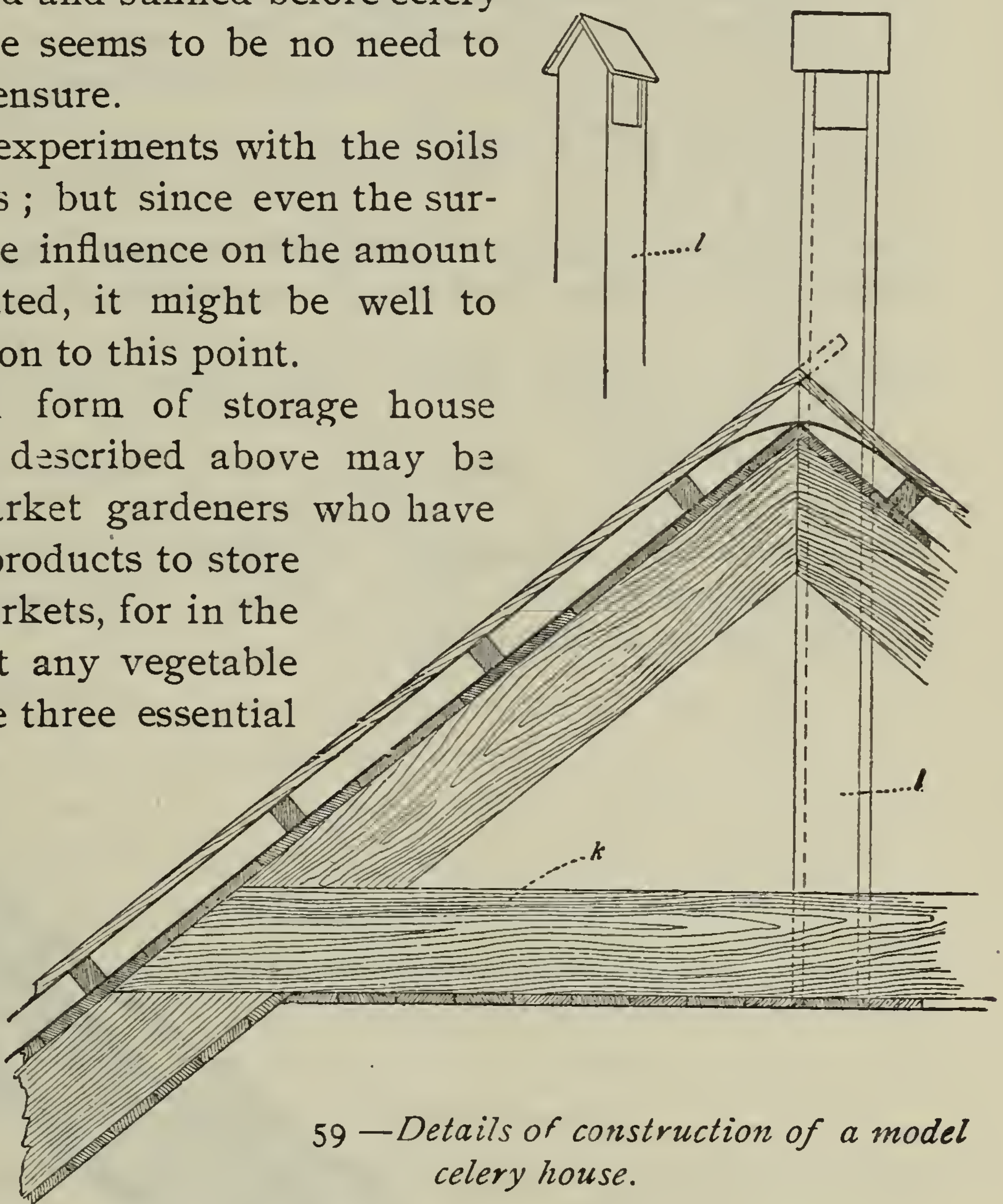
with air chambers and paper linings, affording the best protection against cold. The additional large air chamber above the collar beams, with its separate windows, seems also desirable. There are large double doors at each end, and the space between each outer and inner door is large, and the connections well arranged for the exclusion of cold air. It seems of sufficient interest to give a view of such a storage house; but full details of construction may not be entered upon in this connection. It will be seen that Fig. 59 shows the construction of the peak and collar-beam (k) of the house, and also of the ventilator (l, l). Fig. 60 shows the detail of the roof construction. The plate (h) is held firmly to the wall by a tongue (i) let into the brick work. The rafter is b. On this is a thickness of sheathing upon either side (a, c), with an air-space at e, and outer sheathing at g, and building paper at d and f. The cost of labor and materials is about $500. An interior view of this house is shown in Fig. 58 (page 200). It was stocked with celery at the time this photograph was taken, and in

spite of having been harvested early, the plants were fairing well.

I have seen a cheaper and modified form of the above structure provided with a single air chamber outside of the rafters and first boarding, with tarred paper covering the final layer of boards. The odor of tar in the house has caused comment; but if the house is well aired and sunned before celery is admitted, there seems to be no need to fear even local censure.

I know of no experiments with the soils of storage houses; but since even the surface soil has some influence on the amount of water evaporated, it might be well to give some attention to this point.

The improved form of storage house which has been described above may be suggestive to market gardeners who have other vegetable products to store for the winter markets, for in the storage of almost any vegetable product the same three essential features are to be borne in mind, viz.: (1) protection against freezing; (2) a temperature so low that the activities of the plant may not be incited and that the growth of fungi may be discouraged; and (3) proper protection against excessive moisture.



59 —*Details of construction of a model celery house.*

B. BIBLIOGRAPHY OF THE CELERY BLIGHTS.

Atkinson, Geo. F.—Note on the Cercospora of Celery Blight. Bulletin 49, Cornell Ag'l. Exp. Station, Dec. 1892.

———On the Fungus of Celery Blight. Am. Monthly Mic. Journ., **xiv.** 115, No. 4, Apr. 1893.

Chester, F. D.—A Leaf Spot of Celery (Notes on Three New or Noteworthy Diseases of Plants). Bullt. Torry Bot. Club, xviii. 372, No. 12, Dec., 1891.

———A Noteworthy Disease of Celery. Report Delaware Ag'l Exp. Sta., 1891, p 63.

Galloway, B. T.—Additional Notes on Celery Leaf Blight. Report U. S. Dept. Agriculture, 1888, p. 398.

———Report. U. S. Dept. Agriculture, 1892, p. 234.

Halsted, B. D.—Some Fungous Diseases of the Celery. Report New Jersey Ag'l Exp. Sta., 1891, p. 250.

Humphrey, J. E.—The Blight of Celery. Report Mass. Ag'l Exp. Sta., 1891, p. 231.

New York Ag'l Exp. Sta.—Some Celery Diseases. Bulleten 51, 1893.

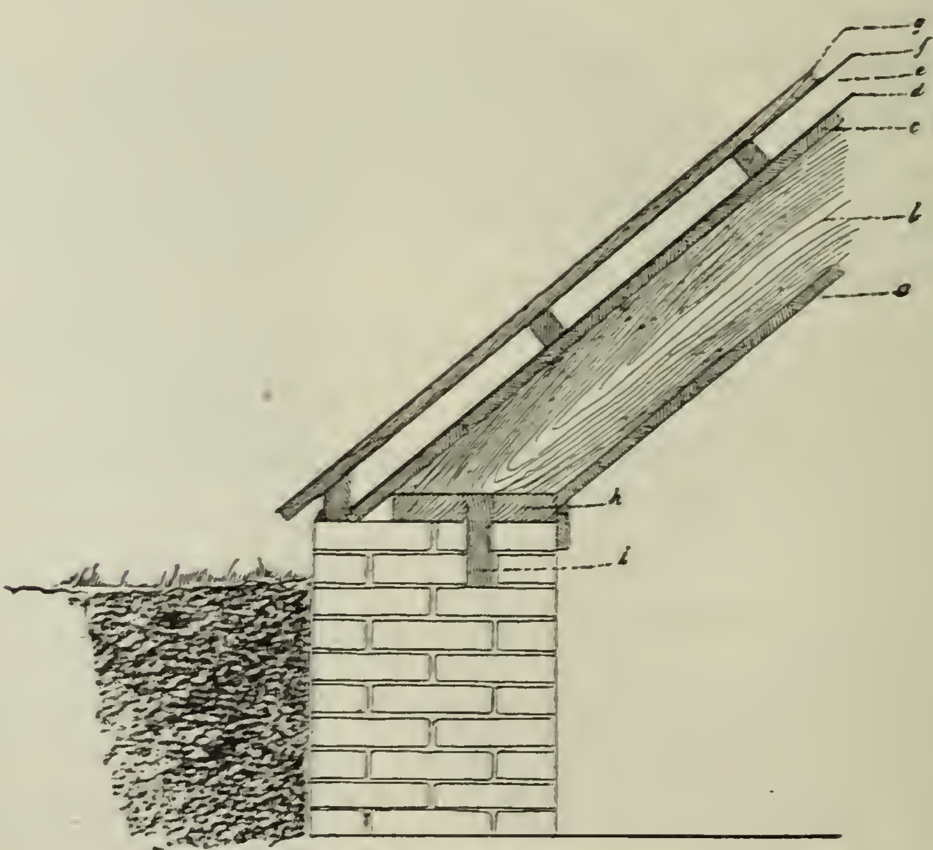
Scribner, F. L.—Celery Leaf Blight. Report U. S. Dept. Agriculture, 1886, p. 117.

Sturgis, W. C.—Celery Blight. Report Conn. (New Haven) Ag'l Exp. Sta., 1892, p. 44.

———Celery Blight. Bulletin 115, Conn. (New Haven) Ag'l Exp. Sta. p. 17, 1893.

———Provisional Bibliography of Works on Fungous and Bacterial Diseases of Economic Plants. Bulletin 118, Conn. (New Haven) Ag'l Exp. Sta. p. 14, March, 1894.

B. M. DUGGAR.



60.—*Details of construction.*

II. EXPERIMENTS WITH FERTILIZERS ON CELERY.

Upon the 26th of June, 1896, an experiment in fertilizing celery was laid out near Rome, New York, upon the premises of B. F. Richardson. The area was flat muck land, of half-wild meadow, broken up that year. It had never grown celery and had never received fertilizers.

The rows of celery were 28 rods long and 4 feet apart. Each row, therefore, represents about one-twenty-fourth of an acre of land. The plants of Golden Self-Blanching were set from four to six inches apart in the row, and the other varieties from six to eight inches. The fertilizer was carefully strewn by hand in a little furrow made upon either side of the row, after the plants were established in the soil, and it was then covered with earth. Care was exercised to keep the material from coming nearer than two or three inches to the plants. The season turned out to be very dry, and therefore the crop was less than it should have been. However, it was given excellent care, and there were marked differences in the plots when final notes were taken on the 31st of October. The celery was bleached by banking with earth.

The samples shown in the illustrations were taken by selecting six average plants from near the end of each row. The weights of these six average plants are entered in the records below. Chemical analyses were made from these samples, as displayed on page 229. The photographs showing the samples are all taken to the same scale. The weights of all the plants in each plot were also taken, but are not reported here.

VIII. Seven rows Golden Self-Blanching celery, set June 20. Received July 17, 100 lbs., high-grade sulfate of potash, 14 lbs. to the row.

Crop rather poor. Fig. 61.

Six plants, 4 lbs., 1 oz.

IX. Seven rows Golden Self-Blanching, set June 20. Received July 17, 100 lbs., high-grade muriate of potash.

Crop very much better than in plot VIII., the stalks being much thicker, broader and stronger. The difference was such as to impress any observer. Figs. 61, 63.

Six plants, 5 lbs., 14 ozs.

61.—*Two left-hand plants (VIII.) are from sulfate of potash rows and the right-hand ones (IX.) from muriate of potash rows.*

62.—*Plants 1 and 3 from no fertilizer row; plants 2 and 4 from wood ashes rows.*

64.—*South Carolina rock, one bunch of six plants (XII.) and bone black, one bunch of six plants (XIV.).*

65.—*One bunch, six plants, sulfate of potash (XV.), and one bunch, six plants, check (XVI.). Notice the small stalks in the latter.*

X. One row Golden Self-Blanching, set June 20. No fertilizer.
Crop almost worthless. Figs. 62, 63.

Six plants, 2 lbs., 9 ozs.

XI. Three rows Golden Self-Blanching, set June 20. Received 200 lbs. wood ashes July 17. (The ashes analyzed 6.32 per cent potash, and 1.87 per cent phosphoric acid.)

Crop the best in the entire plantation, the stalks being numerous and very stocky and solid. Figs. 62 and 63.

Six plants, 7 lbs., 7 ozs.

XII. Five rows Kalamazoo Broad-Ribbed, set June 24. Received July 18, 100 lbs. dissolved South Carolina rock.

Crop medium to poor, the stalks being too slender. Fig. 64.

Six plants, 5 lbs. 2 ozs.

XIII. One row Kalamazoo Broad-Ribbed, set June 24. No fertilizer.

Crop unusually good for a check, being nearly equal to XII., but the row stood near a dead furrow and no doubt received some benefit from deeper plowing at that point.

XIV. Five rows Kalamazoo Broad-Ribbed, set June 24. Received July 18, 100 lbs. bone black.

Crop much better than XII., the plants being much thicker and heavier. Fig. 64.

Six plants, 6 lbs.

XV. Six rows White Plume, set June 25. Received July 18, 100 lbs. sulfate of potash.

Crop fair. Fig. 65.

Six plants, 5 lbs., 12 ozs.

One row in this plot (shown in Fig. 66) was almost ruined by being burned by the sulfate, the material having been scattered directly upon the row and much of it striking the plants.

XVI. One row White Plume, set June 25. No fertilizer.

Crop poor, stalks many but small. Fig. 65.

Six plants, 5 lbs. 15 ozs.

XVII. Six rows White Plume, set June 25. Received July 18, 200 lbs. sulfate of potash.

Crop heavy, with much broader and heavier plants than in XV.

XVIII. One row Golden Self-Blanching, set July 8. Received July 28, 10 lbs. nitrate of soda.

Crop poor, the stalks being stocky but very sort. Fig. 67.

Six plants, 2 lbs. 14 ozs.

XIX. Two rows Golden Self-Blanching, set July 8. No fertilizer.

Crop worthless. Fig. 67.

Six plants, 1 lb. 8 ozs.

XX. Seven rows Golden Self-Blanching, set July 21. Received July 28, 25 lbs. nitrate of soda, 75 lbs. dissolved South Carolina rock, 100 lbs. sulfate of potash.

Crop fair. Fig. 67.

Six plants, 4 lbs. 6 ozs.

XXI. Two rows Golden Self-Blanching, set July 21. No fertilizer.

Crop worthless.

XXII. Seven rows Golden Self-Blanching, set July 22. Received July 28, 50 lbs. nitrate of soda, 100 lbs. dissolved South Carolina rock, 200 lbs. sulfate of potash.

Crop late because of late setting, but Mr. Richardson regarded it as the best lot on the plantation considering the chance it had.

All these records show that wood-ashes gave the best results, although a combination of nitrate of soda, South Carolina rock and sulfate of potash (plot XXII.) promises to do well. Muriate of potash excelled the sulfate. Nitrate of soda alone gave poor returns. The check (no fertilizer) plots were not worth the growing.

It should be said that although this test was made with much pains, no generalizations should be drawn from it. The subject needs to be studied a number of years and in more detail before definite conclusions can be drawn. This paper is meant as a report of progress, and to call the attention of those who are experimenting with celery fertilizers to our desire to obtain more specific information. We shall endeavor to make similar experiments the coming season. It will be observed, however, that the results upon these plots were as emphatic as could have been wished.

The chemist was asked to help interpret the results, and his analyses of a plant from each plot, and of the soil, are given below.

c *b* *a*

63.—*Celery field, showing muriate of potash rows at* a, *the no fertilizer row at* b (*notice how narrow and small the row is*), *and the wood ashes rows at* c.

66.—*Sulfate of potash plot, showing one row burned by the application of the potash on the plants.*

The report of George W. Cavanaugh, assistant chemist to the Experiment Station, is as follows:

"The four principal fertilizing elements nitrogen (N), phosphoric acid (P_2O_5), potash (K_2O) and lime (CaO) were determined in the dry substance of the celery plant, roots excluded.

"In samples XVIII. and XX., nitrates were found in appreciable quantities. Potash seems to be the most variable ingredient ranging from 4.63 per cent to 1.97 per cent.

"Whenever potash was used in the fertilizers it is found in

67.—*Bunches of six plants of each of three lots: XVIII., nitrate of soda; XIX., no fertilizer; XX., nitrate of soda, S. Car. rock, sulfate of potash.*

greater amount in the plant than in those plants not so fertilized, except in case of No. XVI., which for some unknown reason ranks highest.

"In sample XVIII. there seems to be evidence of a partial replacement of potash by soda.

"The same result seems to follow from a comparison of samples VIII. and XX. In the former when sulfate of potash was used

alone 4.40 per cent. was found in the plant as against 2.84 per cent where nitrate of soda was used with the potash. Phosphoric acid and lime seem to be quite constant.

"While no conclusive result can be drawn from this one set of analyses it seems probable that nitrogen and potash are the plant-foods most required."

ANALYSES OF CELERY PLANTS.

Plots.	Nitrogen per cent.	Phosphoric acid per cent.	Potash per cent.	Lime per cent.
VIII. K_2SO_4	4.24	.72	4.40	.51
IX. K Cl	3.44	.78	4.48	.40
X. None	4.08	.67	2.96	.43
XI. Ashes	3.64	.90	3.26	.41
XII. P_2O_5	4.17	.86	2.46	.36
XIV. P_2O_5	3.77	.93	2.48	.38
XVI. None	4.47	.89	4.63	.49
XVIII. $NaNO_3$	4.81	.70	1.97	.41
XIX. None	4.55	.79	2.80	.50
XX. $NaNO_3$, K_2SO_4, P_2O_5	4.46	.84	2.84	.42

It is apparent that these figures throw little light upon the reasons for our curious results,—the high yield with potash and the very small yields with nitrogen. It was then decided to make an analysis of the soil, to find if its composition could aid in interpreting the results of the experiment. The soil was found to show no acidity. Mr. Cavanaugh found a very high content of nitrogen, phosphoric acid and potash. It was then suggested that the potash, whilst large in amount, might be unavailable. Accordingly, the potash and phosphoric acid were tested for availability, when it was found that the potash was practically all unavailable whilst the phosphoric acid was in a very available condition (as determined by digesting in a one-half per cent of hydrochloric acid for 5 hours at 40°c). Mr. Cavanaugh's figures are as follows :

ANALYSIS OF CELERY MUCK, CALCULATED TO DRY SUBSTANCE.

			Availability.
Nitrogen	1.87	per cent.	
Phosphoric acid	.50	"	.065
Potash	.54	"	merest trace
Lime	2.20	"	
Humus	29.29	"	

The unavailability of the potash seems to explain the excellent results which were obtained from the wood ashes. The chemist now suggests the use of caustic lime upon the land, in the place of fertilizers, in order to determine if the potash may be made available. It is expected that experiments will be continued along this interesting line this year.

L. H. BAILEY.

Bulletin 133. **April, 1897.**

Cornell University Agricultural Experiment Station.

ITHACA, N. Y.

ENTOMOLOGICAL DIVISION.

THE Army-worm IN NEW YORK.

"June 27, 1743. There are millions of worms, in armies, appearing and threatening to cut off every green thing; people are exceedingly alarmed."

"July 1, 1743. Days of fasting are kept in one place and another, on account of the worms." *Extracts from the Journal of Rev. Thomas Smith, Falmouth, Me.*

By M. V. SLINGERLAND.

PUBLISHED BY THE UNIVERSITY,
ITHACA, N. Y.
1897.

ORGANIZATION.

BOARD OF CONTROL:

THE TRUSTEES OF THE UNIVERSITY.

STATION COUNCIL.

President, JACOB GOULD SCHURMAN.

Hon. A. D. WHITE,	Trustee of the University.
Hon. B. F. TRACY,	President State Agricultural Society.
Professor I. P. ROBERTS,	Agriculture.
Professor G. C. CALDWELL,	Chemistry.
Professor JAMES LAW,	Veterinary Science.
Professor J. H. COMSTOCK,	Entomology.
Professor L. H. BAILEY,	Horticulture.
Professor H. H. WING,	Dairy Husbandry.
Professor G. F. ATKINSON,	Botany.

OFFICERS OF THE STATION.

I. P. ROBERTS,	Director.
E. L. WILLIAMS,	Treasurer.
EDWARD A. BUTLER,	Clerk.

ASSISTANTS.

M. V. SLINGERLAND,	Entomology.
G. W. CAVANAUGH,	Chemistry.
L. A. CLINTON,	Agriculture.

In pursuance of the provisions of Chapter 128 of the Laws of 1897, the following persons have been appointed investigators and instructors in the College of Agriculture of Cornell University to serve throughout the state according to the needs of the several localities for a portion or all of the year.

J. W. SPENCER,	M. V. SLINGERLAND,	A. L. KNISLEY,
G. T. POWELL,	B. M. DUGGAR,	C. E. HUNN,
G. A. SMITH,	J. L. STONE,	H. B. CANNON, Chief Clerk.

Office of the Director, 20 Morrill Hall.
The regular bulletins of the Station are sent free to all who request them.

BULLETINS OF 1897.

124. The Pistol-Case-Bearer in western New York.
125. A Disease of Currant Canes.
126. The Currant-Stem Girdler and The Raspberry-Cane Maggot.
127. A Second Account of Sweet Peas.
128. A Talk about Dahlias.
129. How to Conduct Field Experiments with Fertilizers.
130. Potato Culture.
131. Notes upon Plums.
132. Notes Upon Celery.
133. The Army-worm in New York.

68.—*Army-worms at work on a corn plant. Nearly natural size.*

69.—a, *army-worm moth at rest, natural size;* b, *moth with wings expanded;* c, *the moth, twice natural size;* d, e, f, g, *eggs of army-worm moth as they are laid in grass leaves, much enlarged.*

THE ARMY-WORM IN NEW YORK.

Leucania unipuncta Haworth.

Order LEPIDOPTERA ; family NOCTUIDÆ.

Perhaps no common name of an insect is so familiar to agriculturists and others as that of "army-worm." However, but comparatively few people are familiar with the story of an army-worm's life,—what it is, where it comes from, the wonderful transformations it undergoes, and many other interesting facts about it. The most serious outbreak of this insect known in the history of New York state and of the country at large occurred last year. As the newspapers teemed with more or less exaggerated accounts of its ravages and habits, it attracted unusual attention from all classes, resulting in a greater demand for definite, detailed, illustrated information than we were able to supply at the time. Fortunately we succeeded in breeding many of the insects through their different stages and broods in cages at the insectary, and were thus enabled to obtain many new and life-like pictures of army-worms, their parents, and other interesting phases of their life. In order that agriculturists and others may be prepared with definite information in case of future outbreaks of the insect in New York, the following account of its work in the state has been prepared.

WHAT ARE ARMY-WORMS.

The name "army-worm" has been applied to several different insects which sometimes appear in great numbers and devastate large areas of field or orchard crops. The term is sometimes applied to the canker-worm in many localities in our state. However, what has come to be recognized as the army-worm proper or *the* army-worm by entomologists is shown at work, nearly natural size, in figure 68, and twice natural size in figure 70. It is a striped, sixteen-legged larva or caterpillar, resembling, and in fact, closely allied to, the well-known cutworms. It is aptly

called the "army-worm" because whenever it appears in injurious numbers, after destroying the vegetation in one field, the caterpillars always march like an army to other fields. The parents of army-worms are moths (see figure 69) which belong to a great family of insects known as Noctuids or owlet-moths. Most of the moths or "mlllers" that fly into our houses at night, attracted by the lights, are members of this family.

THE CATERPILLARS AND THEIR PARENTS DESCRIBED.

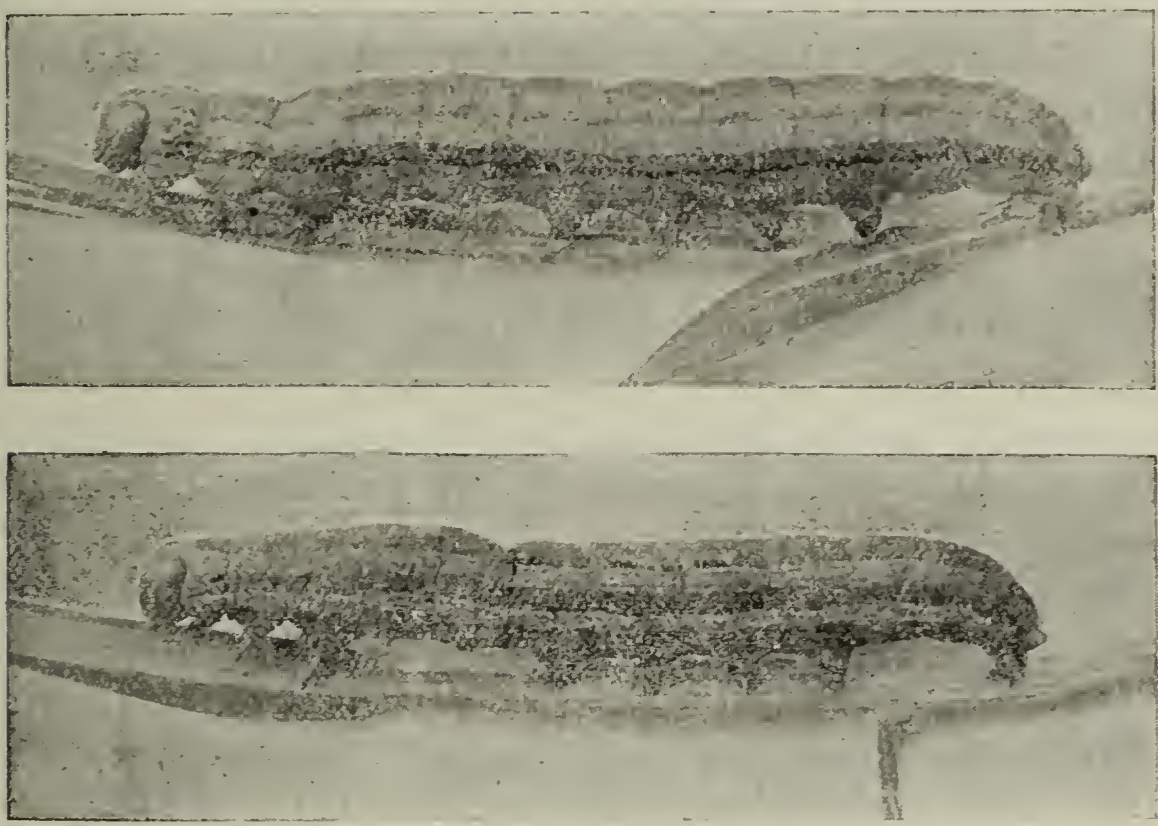
When full-grown, army-worms measure nearly an inch and a half in length. They are of a general greenish-black color, much lighter on the venter which is more or less mottled with blackish, and each side bears several distinct stripes.

Along each side of the body extend three stripes of about the same width; the one just below the spiracles is of a light greenish-yellow with whitish edges; the one bordering on the dorsum is a little darker with a mottled greenish-black center and narrow white lines along its edges; the central stripe, or the one with the spiracles in its lower edge, is black, sometimes lighter along its center. The dorsum is finely mottled with greenish-black and closely resembles the dark stigmatal stripe in color; along the middle line of the dorsum there extends a narrow white stripe, usually quite indistinct except on the thoracic and anal segments. The six true legs are light brown in color, and each pro-leg is marked with a large, shiny, blackish spot. The head is of a greenish-brown color, rather coarsely mottled with black which merges into distinct blackish stripes along the sutures.

There is considerable variation in general color among the caterpillars, some being much lighter than others, due to differences in the intensity of the stripes and the mottlings on the body. In some cases this difference was so great as to lead to doubts of the specimens being true army-worms. Two extremes of variation are illustrated in figure 70; in one instance all the army-worms received from one locality were like the one in the upper part of the figure, while those sent in from another army were all dark like the lower one.

The parent insect—the moth—is shown natural size at rest at *a*, and with wings expanded at *b*, in figure 69; at *c* in this figure the moth is represented twice natural size. As these figures indicate, the adult insect is a very plain little "miller." Its principal characteristic markings are the distinct white spot near the center, and the dark shade or stripe in the upper outer angle, of

each front wing. The general color of the front wings is clay or fawn, much specked with black scales; a row of more or less distinct black dots, one on each vein, crosses the wing about midway between the white spot and the outer margin; often the veins are outlined for a portion of their length by white scales. The hind wings are of a dusky brownish color, darker towards the outer margin, and with the veins blackish.



70.—*Light and dark varieties of army-worms, twice natural size.*

There are no differences in color between the male and female moths, but the abdomen of the female is more pointed, and her antennæ are much smoother than the hairy or ciliate antennæ of the male.

The moths are very uniform in their coloring and markings; practically the only variations are in the number of the black scales scattered over the front wings, and some moths are a trifle lighter or darker with more or less of a reddish or rust tinge. There is considerable variation in size, the distance across the outstretched wings ranging from a little less than one and a half inches to two inches. The moths bred from the lightest colored army-worms do not differ from those reared from the darkest caterpillars.

The moth may be readily distinguished from other similar

moths by the conspicuous white spot in the center of each front wing. It was doubtless this distinctive mark that suggested the specific name of the insect—*unipuncta.*

HISTORICAL.

Its general distribution and early history.—Apparently the native home of the army-worm is in North America, although it is known to occur in England, South America, India, Java, Maderia, Australia and New Zealand, thus making it nearly a cosmopolitan insect. However, it is known as an especially injurious insect only in the United States, east of the Rocky Mountains and in Canada. "The region in which it especially flourishes extends from Iowa to Maine and from Texas to Alabama. East of the Blue Ridge Mountains its southerly range as an injurious species extends to North Carolina. The moth is often captured outside these limits and frequently in considerable numbers, but the caterpillar does not seem elsewhere to be a factor in agriculture."

What has come to be recognized as the first published account of this insect is quoted on the title page below the frontispiece. 1743 is always mentioned as the first army-worm year of which we have pretty definite proof. Perhaps it was the army-worm that appeared by the millions in Massachusetts in 1762 and ate up the corn. Graphic and definite accounts have been recorded of the ravages of the insect in New England in 1770 and 1790. The next army-worm year was in 1817, and since 1825 the insect has appeared in injurious numbers somewhere in the United States almost every year; but rarely, if ever, has the insect been destructive in the same locality in two successive years.

The army-worm was known in the early chronicles as "the black worm;" just when it came to be known as "the army-worm" we have not ascertained. Sometime in the latter part of the eighteenth century, a specimen of the adult insect—the moth—found its way into the then celebrated collection of a Mr. Francillon in London. Upon the breaking up and sale of that collection early in this century, this moth passed into the possession of a Mr. Haworth, who published a description of it in 1810; he named it *unipuncta*, the white speck.

It is a curious fact that no one seems to have discovered what the parents of the army-worms were like until 1855, when Mr. Kirkpatrick reared some of the moths in Ohio. It was not until 1861 that Dr. Fitch, then State Entomologist of New York, identified the army-worm moth as the same insect which had been described in England fifty years before.

Previous army-worm years in New York.—Apparently the first record of the occurrence of the army-worm in New York state is the following taken from the *Albany Argus* for 1817: "The black worm is destroying the vegetation in the northern towns of Rensselaer and the eastern section of Saratoga counties. Many meadows and pastures have been rendered by their depredations as barren as a heath."

The insect does not seem to have again attracted attention in our state for forty-four years or until 1861.* This is by far the most celebrated of the army-worm years, because the worms appeared in destructive numbers over an immense extent of country (twenty states were damaged to a greater or less extent), and also because this outbreak called forth several elaborate articles by the leading writers upon insects. In New York state the worms appeared in the vicinity of Buffalo, and at several other points towards the western and southern line of the state; and also in many places on Long Island.

In 1872, an army of the worms was reported from Tioga County. Again in 1875, which was a notable army-worm year throughout the country, the insect was very destructive in the same county and was reported as swarming on Long Island. Dr. Lintner states (*Country Gentleman*, 1877, p. 347) that the worms abounded in many portions of the state in 1876 and did serious damage, but the next year the moths were rarely seen. 1880 was also a notable army-worm year, especially in New York state. The worms were destructive in the southern and eastern counties of the state in August, and on Long Island the damage done in June was very great, creating much alarm. Bushels of the worms

* Dr. Riley states (3d Rept. Ent. Com., p. 95): "From an old number of the *Country Gentleman*, we learn that it did some damage in western New York." We have been unable to find this reference, nor does Dr. Fitch refer to it in his detailed account published in 1861.

were captured in post-holes dug in ditches on Long Island in 1880, but in 1881 scarcely any were seen on the Island.

In August, 1882, the insect appeared in formidable numbers near Saratoga Springs, and was also very destructive in Suffolk County. In 1885, the worms were reported as doing much damage in oats in Orange County. They next attracted attention in Orleans County in 1888, where they injured the barley crop twenty per cent. Two years later (1890) the worms are reported to have destroyed many acres of timothy in Queen's County. This completes the record of appearances in destructive numbers of the army-worm in New York state previous to 1896.

NOTES ON THE OUTBREAK OF 1896.

During the spring and summer of 1896, the army-worm appeared in destructive numbers in portions of ten states, constituting what is probably the most serious outbreak of the pest known in the history of the country. In some states most of the damage was done in May, but usually it was the July brood which appeared in almost incredible numbers; in a few localities, however, it was not until September that the pest was seen in injurious numbers.

In New York state the outbreak was the most wide-spread and most destructive of any before recorded. We have authentic reports of armies of the worms having worked in forty-eight of the sixty counties of the state. We heard nothing of the insect in the state until about July 1st, when letters, telegrams, and even long-distance telephone messages began to pour in from all sections. A circular letter and telegram were prepared and for nearly three weeks in July, we were kept busy answering the urgent requests of the hundreds of correspondents whose crops, in many cases, were disappearing, often at the rate of an acre or more per day, down the throats of the armies of hungry worms.

Nearly all kinds of field crops were ravaged by the caterpillars. Corn and oats seem to have suffered the most; there is no data upon which to base any definite estimates, but one may safely say that thousands of acres of these two crops alone were ruined by the worms in New York. In many localities, rye, barley, wheat, millet, meadows, pasture lands, and Hungarian grass suffered

equally as much as, and in some cases more than, corn or oats. One army of the worms which we visited had stripped every leaf from forty acres of rye and had cut off one-third of the heads before the farmer discovered the presence of the enemy on his farm. When we reached his place, his corn and oats in adjoining fields were disappearing at the rate of an acre or two a day, and the lane across which the worms were marching presented a desolate appearance, scarcely a green blade of grass having escaped the jaws of the hungry horde. Many farmers had similar experiences with the insect. Often whole fields of rye or other crops would be ruined before the culprits were discovered. Some farmers, hoping to save their oat crop cut the grain before it was fairly ripe, binding it into bundles and "shocking it" as usual; but quarts of the worms simply gathered under and in these shocks and continued their destructive work on the drying grain, often ruining the whole crop.

The favorite breeding places for the worms are the low places in pastures and meadows where the vegetation grows the rankest, and in many cases it was evident that the armies started from such places in 1896. Often, however, the indications were that the worms were born in the rye or oat field where their ravages were first noticed. As there was nothing to indicate that 1896 was to be an "army-worm year," no one was on the lookout for the insect, and doubtless few, if any, farmers discovered the worms when they were small and before they had been forced to abandon their breeding grounds and march to new pastures in search of food to satisfy their voracious appetites. The larger proportion of the damage done in 1896 might have been averted had the farmers been able to apply remedial measures before the worms had spread far from their birthplace instead of when they were half-grown or more, with larger appetites, and were on the march.

Although the outbreak of the insect was so general all over the state, oftentimes the worms were confined to one or two farms in a town; one man's crops might be ruined by them while another army of the worms might not occur within a radius of several miles.

To fully realize the destructive capabilities of the insect one must see, no description will suffice, an army of the worms on the

march and at work. In most cases, the caterpillars in each of these armies must have been numbered by the millions; even an approximate estimate of the number of worms in a single army would have been impracticable. Oftentimes when an army was marching across a lane or roadway, nearly the entire surface of the ground for several rods would be covered with the crawling mass of worms; one could not step without crushing several of them. Is it to be wondered at that when such a vast horde of hungry creatures reach a field of young corn, acres of the plants soon look like the one shown in figure 68? They soon strip all the leaves from the stalks of oats, rye, and similar plants, and often cut off many of the heads, leaving them uneaten on the ground. In one instance, a barn loomed up before the worms directly in their line of march, but nothing daunted, many of them valiantly scaled the perpendicular wall and soon succeeded in getting over the eaves onto the roof. Here, however, they met their Waterloo, either from the exposure on the heated shingles to the sun's rays or from other causes, and a windrow of dead worms was formed under the eaves.

The worms feed mostly at night, remaining hidden during the day in the soil or under chunks of dirt or anything that will afford protection; many of them find shelter down in the cavities at the bases of the unfolding corn leaves. On cloudy days the worms usually feed during the day, and often many of the worms may be found at work on sunshiny days.

In almost every case it was the July brood of worms only which ravaged crops; apparently in none of these instances did the May or the September broods of the caterpillars attract attention. However in at least two localities (Cheviot, Columbia Co. and Warwick, Orange Co.), it was only the September brood of worms which were numerous enough to be noticeably destructive; curiously enough the insect had not been seen in these localities before during the year. Thus, while in most localities all of the damage was done in July, and in a few places the worms were not injuriously numerous until September, it is to be noted that we have no evidence that more than one of at least three broods of the insect was noticeably injurious in any locality during 1896. A probable explanation of this noteworthy fact will be brought

out later on in the discussion of the enemies of the army-worm.

INDICATIONS OF THE PRESENCE OF ARMY-WORMS.

Unfortunately, even when army-worms occur in immense numbers, farmers rarely become aware of their presence until they are about half-grown, when they have usually spread some distance from where they hatched, and have often already done much damage. Last year, one farmer noticed that a forty-acre field of rye seemed to be ripening unusually early, but he did not discover the cause until a few days later when an immense army of the caterpillars began marching from this field into adjoining corn and oat crops ; an examination of the rye showed that the worms had eaten nearly every rye leaf in the whole field and had also cut off about one-third of the heads. That the insect gets such a start before it is discovered, is doubtless largely due to the fact that it is not a "standard" pest (that is, one which may be expected in injurious numbers almost every year, like the Codlin moth) and thus farmers, not expecting it, are not on the lookout for it. As it is impossible to predict with any degree of certainty when army-worms may be expected, this unfortunate condition of affairs seems to have no practicable remedy.

A whole army of the worms are often hatched in a few square rods or less of rank growing grass in a low, damp spot in a large pasture or meadow. Such a small area is easily overlooked, although the little caterpillars may have eaten enough of the grass to enable one, on the lookout for them, to readily discover their presence before they have spread far and have done much damage. It would be an easy matter to check an army of these very destructive worms in field crops if it could be discovered before it had spread far from its comparatively small breeding ground.

WHAT ARMY-WORMS EAT, AND THEIR CAPACITY FOR INJURY.

Army-worms include in their menu a wide range of food-plants. They seem to prefer the grasses and grains. Timothy, wheat, oats, corn, rye, and barley, they seem to relish best ; and millet, Hungarian grass, sorghum, or flax do not come amiss. They have also been known to eat onions, peas, beans and other garden

crops. Cranberry crops have been greatly damaged by them, and in one instance "an army of the worms, in passing through a strawberry patch, devoured both the leaves of the plant and the unripe fruit." Experiments have shown that in confinement the worms will live, thrive, and undergo their transformations when fed exclusively upon either the garden poppy, beet, lettuce, cabbage, raspberry, onion, parsnip, radish, carrots, or pea. They refused to feed, however, on bean, cotton, grape, and hemlock.

Ordinarily clover is not eaten by the worms; it is said that "a timothy field is often eaten to the ground, leaving the clover scattered through it standing." In 1880, however, a remarkable exception occurred in New Jersey where in some localities clover-eating by the worms was the rule and not the exception.

Fruit growers have little to fear from this pest. In one case, as mentioned above, a strawberry bed was injured by an army of the worms, and there is but one record of their having eaten the leaves of fruit trees.

Finally, it may be of interest to know, that when on the march, the worms have been known to not hesitate at cannibalism to satisfy their hunger, and many individuals have been killed and devoured by their stronger comrades.

It is a striking fact, that, although the army-worm is widely spread throughout the world, it is notably destructive only in the northern half of the Uuited States; and in this section, its capacity for injury is very great. Almost every year it appears somewhere in this area and injures crops to the amount of hundreds of thousands of dollars. As one can readily understand, it is a difficult matter to estimate the loss occasioned by the ravages of an insect over a large area. The damage done by the army-worm in western Massachusetts in 1861 has been estimated at $500,000. The oat crop of Indiana and Illinois is estimated to have been damaged by the insect in 1881 to the extent of about $750,000. We have but little data upon which to base an estimate of the injury done by the worms in New York in 1896. It has been stated, however, that the damage from the insect in Massachusetts last year would amount to upward of $250,000; and we believe that at least as many dollars worth of the crops of timothy, oats

and corn of New York farmers also went down the throats of the ravaging armies of the worms in 1896.

THE STORY OF AN ARMY-WORM'S LIFE.

Only those who have closely watched the growth and wonderful transformations of an insect can realize how fascinating is such a study of life. It is astonishing how much ignorance there is among the great mass of the people in regard to insects and their life-stories. But few of the hundreds of farmers who suffered from the ravages of the army-worm last year, had any definite ideas as to where the worms came from or what became of them. Our observations lead us to believe that those who know the most about the habits and lives of their insect pests, are the ones who best succeed in conquering these minute foes. Furthermore it must be more interesting to plan a campaign against an enemy with whose habits one is familiar than to go at it haphazard as many do. The life-history of the army-worm varies somewhat in different latitudes; the following discussion is applicable, in most cases, only to New York state and similar latitudes.

The egg stage, or how and where its life begins.—Each army-worm begins life in a minute, round, nearly smooth egg of a distinct, yet very light yellow color,* and measuring from 6 mm. to 7 mm. (about .025 of an inch) in diameter. In seeking a place to lay her eggs, the mother insect seems to preferably choose the rankest tufts of grass in pastures or where the growth is the rankest in grain fields or meadows. Finding a suitable stalk of grass or grain, the moth clasps a blade or leaf with her legs and then deftly thrusts her ovipositor into the as yet unfolded base of the leaf or more often down into the sheath where it surrounds the stalk. She is thus engaged from one to four minutes at a spot. During this time from 10 to 50 or even more eggs may be laid and covered with a thin white glutinous substance which fastens them together and also draws the sides of the leaf close around them,

* The egg has always been described as smooth and white. Yet the hundreds of eggs which we have seen had a distinct yellowish tinge, and under the microscope the surface of the shell was prettily marked with a net-work of very fine striæ or ridges; the white substance with which the moth covers her eggs obscures this net-work.

so that nothing but a narrow glistening white streak is visible, as shown much enlarged at *f* and *g* in figure 69. At *d* and *e* in the same figure, part of the sheath of the leaf has been removed to show the eggs and their glutinous covering. Observations indicate that most of the eggs are laid during the earlier part of the night, the moth remaining hidden during the day. It is also said that early in the season the moths prefer to oviposit in the cut straw of old stacks, in hayricks, and even in old fodder stacks of corn or in old bits of corn stalks scattered about in pastures ; eggs have also been found in the spring in young grain.

The immense numbers in which the army-worm often occurs would lead one to suspect that the parent moth must be quite prolific. Careful observation has shown this to be true, for as many as 737 eggs have been found in the body of one moth. They develop rather slowly in the ovaries, as a week or more often elapses between the time of emergence of the moth and the commencement of egg-laying.

Eggs laid in the sheath of grass-blades in our cages in November hatched in from 8 to 10 days. This agrees with other records.

Growth and peculiar habits of the worms.—A day or two before the eggs hatch, the brown jaws of the developing caterpillar can be plainly distinguished through the shell.

The newly hatched worms are nearly 2 mm. (.078 of an inch) in length and are of a translucent whitish color. The head is of a dark brown color and the thoracic shield a little lighter. There are no indications of the stripes which mark their body later. The first pair of abdominal pro-legs are only about one-half as large as, and the second pair are slightly smaller than, the last three pairs. All these undeveloped pro-legs bear the usual hooklets, but whether all are functional or not, we have not determined.

In moving, the little caterpillars loop along like measuring-worms, and when disturbed they drop themselves down at the end of a silken thread which they spin, like canker-worms. As we had seen nothing recorded that would indicate such a habit, we were surprised to find that for the first day or two of their life the caterpillars fed upon the shells of the eggs from which they had just hatched and upon the white glutinous substance which surrounded the eggs. In each case under our observation the little worms ate almost every vestige of these substances before they attacked the live grass leaf. Soon after they began feeding upon the grass, this green food gave their bodies a greenish color. After feeding for a few days, the little worms moult or shed their skin. In the second stage of their life as a caterpillar they have the same looping and spinning habits as before, and the stripes of

the future mature worms begin to appear. After the second moult occurring 3 or 4 days later, or in the third stage, the caterpillars are more distinctly striped, their looping habit is lost, but the front pro-legs are still the smallest, and instead of spinning down when disturbed, the worms curl themselves up. When they reach the fourth stage, 3 or 4 days later, they have many of the characteristics of the mature caterpillars, shown in figure 70, and the pro-legs are of nearly equal size. Two more moults occur at intervals of 3 or 4 days before the worms become full-grown.

This insect thus usually spends from twenty to thirty days of its life as an army-worm or caterpillar.

Army-worms occur every year in most grass-lands, but their habits of feeding mostly at night, remaining hidden during the day, and of dropping when disturbed, render them quite difficult to find unless they occur in large numbers; when young the worms quite closely mimic their food-plants, which also renders their detection less easy. It is said that sometimes one may pass daily through a grass plot where the worms abound, and never suspect their presence until the plot begins to look bare in patches. Their night-feeding habit reminds one of their near allies in the insect world—the cutworms. But the army-worms do not seem to exhibit the wasteful cutting habit of the cutworms, except when they sometimes cut off the heads of wheat and similar grains; usually only the leaves of the grasses and grains are eaten.

The fact that the traveling of the worms in large armies is an abnormal habit, cannot be too strongly insisted upon. It is only when so very abundant, and the food of the vicinity in which they were borne is destroyed, that they march in search of further supplies; they are usually from one-half to two-thirds grown when the march begins.

The rate of travel of the worms when on the march of course varies with the nature of the surface over which they have to crawl. They have been observed to travel at the rate of from one to nearly three feet in a minute, or from four to ten rods per hour.

The Transformations Through the Pupa Stage to the Adult Insect.—Soon after reaching its full growth, an army-worm ordinarily burrows into the ground for an inch or two and there twists its

body about until a smooth cavity or cell is formed. In this earthen cell the caterpillar sheds its skin for the last time and becomes a dark brown, apparently lifeless object—the pupa—shown natural size (at *a*) and enlarged in figure 71. In the latter part of July last year many farmers reported that the army-worms had suddenly left their fields and had disappeared; this simply meant that they had gone into the ground to pupate. When the worms occur in great numbers, many of them change to pupæ under stones, boards, chunks of dirt, or rubbish of any kind, without entering the ground; at such times more or less silk is sometimes spun around the body and particles of earth adhere to it thus forming a slight cocoon. The length of time the insect remains in the pupa state varies with the climate and the season. In the spring and fall the pupa stage apparently lasts from three to four weeks in New York state, while in July only from ten to fifteen days was spent by the insect as a pupa last year.

71.—*The pupae into which army-worms transform. Natural size at* a.

Habits of the moth.—Soon after emerging from their cramped quarters in the pupa, the moths gradually expand their wings and may be seen, resting quietly, hidden during the day in the grasses, in the position shown at *a* in figure 69. The moths usually begin flying about sunset and are doubtless active during the greater part of the night. Their flight is low and is characterized by a quick darting motion. Upon first alighting the wings are kept in motion with a rapid quivering for a moment. They do not appear to be as readily attracted by lights as many other moths. In our extensive trap-lantern experiments conducted in

1889 and 1892, only *one* moth was attracted to the lanterns during the two years.

Doubtless the army-worm moths that emerge in the spring and summer do not live more than two or three weeks; some of them which emerge in the fall live all winter in hibernation. They are fond of liquid sweets, such as a sugar solution painted upon trees to attract other insects; and last year in southern New Jersey they were found in large numbers among the plant-lice on melon vines, doubtless attracted by the "honey dew" secreted by the aphids. They undoubtedly feed upon the nectar of various flowers for they have been taken in the evening upon the blossoms of clover and soap-wort; they have also been found feeding on the blossoms of apple, honeysuckle, and yucca. In August we tried to persuade the moths to lay eggs in our cages where there was no food for them, but all died without ovipositing. We fed the moths which emerged in the fall with sweetened water and they oviposited freely in the cages.

The number of broods of the army-worm in New York.—The army-worm apparently did not attract attention in any locality in New York in 1896 until about July 1st. Then the worms were half or two-thirds grown and had begun to march in armies. From some of these caterpillars we reared the adult insect as early as July 25th, and many moths continued to emerge until about August 15th. We failed to induce these moths to lay eggs, as noted above. In most localities the insect was not noticed again in 1896, but from two places reports reached us, on September 14th and 29th, of the ravages of armies of worms. These were evidently the offspring of the brood of moths which emerged in the latter part of July and the first week in August. From some of the September armies of the worms, moths emerged in our cages from October 31st until November 18th. November 9th, we saw a pair of moths in copulation, and by the 11th the female had laid many eggs on the grass leaves. By the 20th of the month some of the eggs had hatched; other eggs hatched as late as the 27th. Ordinarily this would be rather late for the little caterpillars to obtain food, but last year the weather was favorable at that late date and continued so for some time, so that the

worms fed for several days on the grass leaves before the autumn frosts forced them to prepare for hibernation.

The above observations clearly show that at least two broods of army-worms appeared in New York in 1896, one in July and a later one in September. However, across our southern border, in New Jersey, several armies of the worms ravaged crops in May. Although no noticeable injury seems to have been done by the insect last year in New York before July, their appearance in New Jersey in May and our observations on their habits in the fall are quite conclusive evidence that there must have been at least one brood of the caterpillars previous to July in our state.

We are thus led to conclude that three broods of the army-worm ordinarily occur in New York state. The first brood of the caterpillars are doubtless at work in April and in an "army-worm year" may be forced to march in search of new supplies in May in some localities. This May brood of worms transform early in June into the moths which lay the eggs from which hatch the second brood of worms that were so destructive in July last year. Finally, a third brood of caterpillars, the progeny of the moths from the July brood of worms, work in September.

The most destructive brood.—Usually the second or July brood of the army-worms is the destructive one in New York state and similar latitudes. The first or May brood was noticeably destructive in some localities in New Jersey and Illinois, but seems not to have attracted attention by its injuries in New York. Ninety-five per cent or more of the injury done by the army-worm in New York last year was the work of the second or July brood. In at least two localities, however (Cheviot, Columbia Co., and Warwick, Orange Co.) it was only the September or third brood of the worms which did noticeable damage in 1896. Owing to the activity of their enemies and to other causes, rarely is there more than one *injurious* brood of the insect during the year, and as stated above, this is usually the second or July brood. Thus in those localities which suffer from the ravages of either the first (May) or the second (July) brood of the caterpillars, usually no more armies will be seen during the rest of the season. This is a very important phase of the question for upon it may depend the answer to the question so often asked in July last

year: Will it be safe to plow under our ruined crops and attempt to grow a late crop of something? This question is discussed further on.

How the insect passes the winter.—Our observations, detailed above in discussing the number of broods, further confirm previous records of the hibernation of the insect as a caterpillar. The indications are that in the latitude of New York most of the worms that hibernate are small, not more than half grown.

Among the many records of the capture of the moths, there are but two of their appearance in New York state earlier than about the middle of June; one moth was bred at Albany about the middle of May and we captured one at light on June 2d. This would indicate that the insect does not pass the winter as a moth in our latitude. But the moths have been found in New Jersey "during the entire winter in sheltered places" (Rept. of Entomologist of N. J. Expt. Station for 1896, p. 450). Some writers believe that the insect may also winter as a pupa, but no conclusive evidence has yet appeared to prove this.

Thus the army-worm doubtless hibernates in New York state either as a young caterpillar or in the moth stage; possibly some pupæ winter over.

Briefly summarized then the life-history of the army-worm in New York state seems to be as follows: the moths which may hibernate oviposit early and the caterpillars which hatch from these eggs augmented by the somewhat larger ones which were born late the preceding fall and hibernated, form a May brood of worms that may possibly be numerous enough some years to necessitate their marching to new feeding grounds. The caterpillars of this first brood undergo their transformations through the pupa stage to the adult insect or moth early in June; and the progeny of these moths form a second, and often injurious marching brood of the worms in the early part of July. A third brood of the worms, which are rarely injurious, is developed in September, and the moths into which these transform may lay eggs from which will hatch the young caterpillars that hibernate, or some of the moths themselves may hibernate and oviposit in the spring.

THE NEXT ARMY-WORM YEAR.

Will the army-worms come again next year? In 1896, this was the question uppermost in the minds of many New York farmers whether they suffered from the ravages of the insect during the year or not. This spring there are reports from some localities in the state that farmers are planning to not sow oats and other grains for fear of another invasion of the worms this summer. Of course, no one can say definitely when New York crops will again be ravaged by the pest. Many of our insect foes may come one year in very destructive numbers, but it often happens that the next season we see or hear very little of them. The prevalence of insect life may be likened to a pendulum that swings irregularly in response to the action of some of nature's forces; in the case of insects, their parasitic and predaceous enemies and the variation in their food supply and in climatic conditions are among these forces. However, man has not yet been able to formulate these "ups and downs" so that he can rarely predict with any certainty whether an insect will appear in injurious numbers at any time, even though it may have appeared in very destructive numbers only the year before. This is especially true of the army-worm. No one can predict when we will or will not have an "army-worm year." It has been noted that often an outbreak of the worms has occurred during years which had an unusually dry spring and were preceded by an abnormally dry year; a dry spring gives a more favorable opportunity for the development of the little hibernating caterpillars and those which may hatch early from eggs laid by moths which hibernated. But this combination of climatic conditions does not invariably bring army-worms in injurious numbers.

Since 1825, the insect has appeared in injurious numbers somewhere in the country nearly every year. It has also been injurious somewhere in New York state at intervals of from one to three years since 1872. But, and here is an important historical fact, *rarely if ever, has it ravaged crops in the same locality during two years in succession.* There has been only three general outbreaks of the insect in New York; those occurred in 1861, 1875, and 1880. The other outbreaks were mostly confined to a county

or two. Thus from the historical record of the insect, one might justly conclude that 1897 will not be an "army-worm year" either in our state or in the country at large. Doubtless armies of the worms will appear in very limited localities in some parts of the country but quite probably not on the same farms that were ravaged last year.

There are other reasons for thinking that farmers, whose crops suffered last year, need not lose any brain matter in worrying over the possibility of another "army-worm year" in 1897 or for several years to come; in many cases the worms had not been seen on these farms, until last year, since 1861 or 1875. There is no doubt but what another brood of the worms appeared in New York after the very destructive brood which worked in July. But in those localities where the insect was so destructive in July, apparently nothing was seen of the caterpillars of the next brood which worked in September; they were not numerous enough to attract attention by their injuries. There must have been a fearful decimation among the many millions of worms constituting the July armies either about the time they became full grown or when they had reached the next or pupa stage. And there was. If there had not been, at the normal rate of multiplication, there would have been enough caterpillars developed in September to have caused the ravages of the July brood to have appeared insignificant in comparison. The principal causes of this great decimation in the ranks of these armies of worms are discussed under the natural enemies of the insect. Suffice it is to say here, that as some of the same causes worked upon the September brood, we believe that the number of army-worms which went into hibernation last fall in New York state was not materially greater than in other years when nothing is heard of the insect the year following.

In short, we believe that the history of the insect and the evident and very effective work of its enemies last year, in New York at least, strongly indicate that the army-worm will be a scarce article of diet for the birds in 1897 and for some years to come in most parts of our state. At any rate, we would strongly advise farmers to not hesitate a moment about sowing grain crops

for fear of the worms either in 1897, 1898, or for the next decade, for that matter.

USES THAT MAY BE MADE OF INFESTED FIELDS.

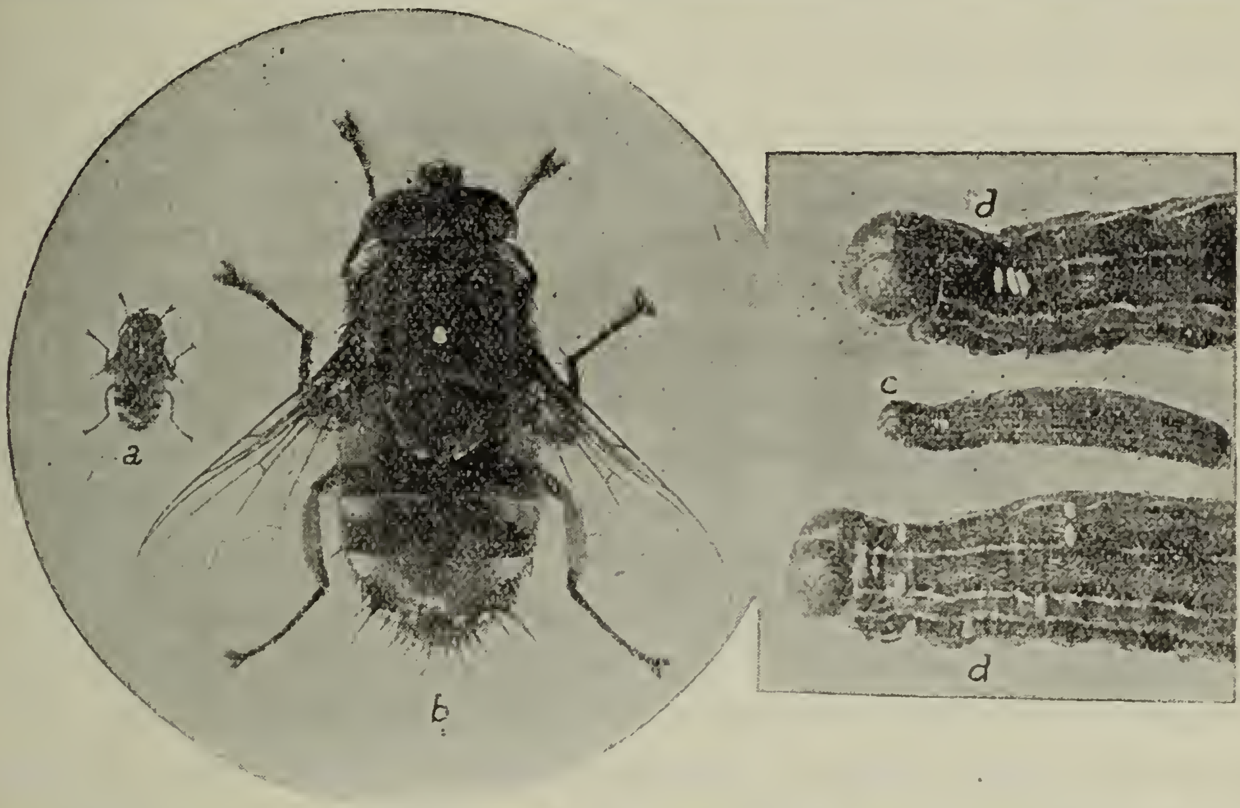
Last year many farmers were at a loss to know what use to make of a crop that had been invaded by an army of the worms whose ravages it was then impossible to check. Those who cut their oats and "shocked" them in the usual manner, hoping that this would check the work of the pest, were doomed to disappointment for the worms continued to work in the shocks, doing much damage. Infested crops of oats and other grains may be cut, and made into hay, or put into silos. This procedure will not facilitate the further multiplication of the insect any more than if the crops were not harvested. What few worms are made into hay or go into the silo will not deleteriously affect the hay or silage.

In many localities in New York state, the great destruction wrought by the worms resulted in a decided shortage of fodder for stock for the fall and winter. Hence, many inquired in July last year what crops, if any, could be grown on the same fields that year. In many cases a shortage of this kind may be partially overcome by putting in at once crops of millet, Hungarian grass, or turnips. Sow from 3 pecks to a bushel of the first two, and about 5 pounds of the latter per acre. If the infested field is plowed, well fitted, lightly harrowed and rolled, and treated to a dressing of fertilizer containing a relatively high per cent. of potash and nitrogen, good crops of these stock foods may be obtained before the winter. Should the turnips be too thick, cultivate by harrowing one or more times soon after they come up. Oats and peas mixed and treated in like manner may also succeed. As the September brood of the worms is rarely numerous enough to be destructive in our state, crops sown in the latter part of July or in August will rarely suffer from the army-worm.

NATURAL ENEMIES.

What a feast many of the birds, including chickens and turkeys, had last year in those localities where the army-worm was numerous. On July 23d, Mr. L. T. Yeomans, of Walworth, N. Y., wrote

us: "We think we have disposed of the greater share of our army-worms. The birds were our greatest helpers. They came in flocks—blackbirds, thrushes, and even the English sparrow condescended to help." Mr. F. A. Sirrine, of the New York Experiment Station staff, has reported that in addition to the birds just mentioned, the cowbird, catbird, robin and the lark were seen feeding on the worms at Washingtonville, N. Y. He states:



72.—THE FARMER'S FRIEND. *The red-tailed tachina fly* (*Winthemia 4-pustulata*). a, *the fly, natural size;* b, *the fly, much enlarged;* c, *army-worm upon which the fly has laid eggs, natural size;* d, *parasitized army-worms, enlarged.*

"It was at first doubted whether the sparrows were in the oat field on a legitimate errand, but close observation showed that each old bird was carrying from one to four worms to its young." After an army's onward march has been checked by the measures discussed under the next heading, then turn in all the chickens and turkeys in the neighborhood.

Among the other vertebrate animals, hogs, toads, and frogs often come in for their share of this dainty food.

Army-worms are also preyed upon by many different kinds of insects. A large number of predaceous beetles (including in many cases their grubs also) often gather about an infested field and greedily feed upon the worms.

An unusually large number of true parasitic insects attack the

army-worm, and they are the most destructive of its natural enemies.

Wherever the worms abound or are on the march, they are usually accompanied by two-winged flies (one is shown natural size at *a*, figure 72), which are often so numerous that their buzzing reminds one of that of a swarm of bees.* These tachina flies are usually the most important and effective of the enemies of the army-worm. A careful examination of a hundred worms in almost every army that ravaged crops in our state last year would have revealed the fact that from ten to seventy-five, or even more in some cases, of them bore upon their backs near the head small white eggs stuck fast to the skin. At *c*, figure 72 is shown a caterpillar bearing three of these eggs natural size; the same eggs are shown enlarged, in position, at *d*, above *c*, and another worm bearing seven similar eggs at *d* below *c*. As many as eighteen of these eggs have been found on a single army-worm, but five is about the usual number. These eggs are stuck to the caterpillar's skin by the tachina flies which buzz around a worm until a favorable opportunity occurs when they swoop down and quickly stick on an egg. Doubtless the eggs are placed near the head to prevent the worm from getting at them with its jaws. From these eggs there soon hatches a maggot which bores its way through the caterpillar's skin and then revels in the juices and fatty tissues of the body, gradually sapping the life of the worm. But few of the army-worms which bear these tell-tale marks—the eggs—of

---

* Two species of these flies were apparently about equally numerous in infested fields in New York last year. One species, the red tailed tachina fly (*Winthemia 4-pustulata* Fabr.), is shown natural size at *a*, and much enlarged at *b* in figure 72. It was first described in this country by Kirkpatrick in 1860, but Mr. D. W. Coquillett has recently stated that it is an European species and was described by Frabricius in the last century. Mr. Coquillett sends us the following synonyms for this insect: *Exorista leucaniae* Kirk.; *Senometopia militaris* Walsh; *Exorista cecropiæ* Riley, M. S.; *Tachina deilephila* O. S.; *Exorista infesta* Williston; *Chaetolyga rufonotata* Bigot; *Chaetolyga rufopicta* Bigot; *Exorista ciliata* Townsend; *Exorista platysamiæ* Townsend; *Exorista datanæ* Townsend.

The other species closely resembles the one just discussed and is known as the yellow-tailed tachina fly (*Belvosia unifasciata* Desv.). It was first described as *Exorista flavicausa* by Riley, but Mr. Coquillett has recently found that Riley's type is the same insect as *B. unifasciata* Desv.

these little parasitic flies, ever succeed in reaching the pupa stage; usually the maggots of the parasites get full grown and leave the caterpillar's body about the time it is also full-grown. The maggots burrow into the ground beneath their host's body and in a few days undergo their transformations to the adult fly.

The deadly work of these tachina flies, of course, does not culminate until the worms have done about all of their damage, but the further development of the insect is stopped and thus the danger of another brood of army-worms is averted. New York farmers were greatly indebted to these little tachina flies last year, or so effectively did they work on the July brood of worms that we believe the comparative insignificance in the numbers of the September brood was largely due to the efforts of the little flies in July. In other words, had it not been for the work of these flies in July, we believe many New York farmers would have suffered from similar armies of the caterpillars in September.

The question has been asked: What do these tachina flies feed upon when the crop of army-worms is comparatively insignificant? The yellow-tailed tachina fly seems to have been bred only from the army-worm, but the red-tailed species is known to work upon at least thirteen other kinds of caterpillars.* Doubtless the former species also has other hosts, and thus when there is a shortage in the army-worm crop, these tachina flies have other choice delicacies in the worm line that may be substituted in their menu.

There are several species of minute four-winged flies which are also parasitic upon the army-worm. The flies "sting" their eggs through the caterpillar's skin, and the grubs that hatch live within the body of their host; when they issue, they spin small, oval, white, silken cocoons attached by loose silk to some neighboring object. As many as ninety-six of the grubs may find

---

* Dr. L. O. Howard writes that this tachina fly has the following hosts: *Deilephila lineata* Fabr.; *Protoparce carolina* Linn.; *Philampelus pandorus* Hueb.; *Alypia 8-maculata* Hueb.; *Attacus promethea* Drury.; *Attacus cecropia* Linn.; *Orgyia leucostigma* S. and A.; *Datana ministra* Drury.; *Adoneta spinuloides* H. S.; *Peridroma saucia* Hueb.; *Feltia herilis* Grote; *Leucania unipuncta* Haw.; *Laphygma frugiperda* S. and A.; *Hemaris diffinis* Boisd.

sustenance in a single army-worm. Sometimes these little parasites are so numerous as to be of much help in checking the pest. Some of the large ichneumon flies also attack the army-worm.*

Last year, in some parts of the state, thousands of the army-worms and many more of their pupæ were killed by a bacterial disease, sort of an insect cholera ; the interior of worms and pupæ affected with this disease appeared rotten.

HOW TO FIGHT THE ARMY-WORM.

As army-worms are not easily and not often discovered in the comparatively limited area in which a whole army of them may breed, a farmer's crop of many acres may be thoroughly infested with a ravenous army before he is aware of it. Where the worms have thus taken possession of a field, but little can be done to destroy them which will not also involve the destruction of the crop. If the surface of the soil were smooth and hard enough, the drawing of a heavy roller over the field would crush many of the worms, but this "roller process" is not often nearly so effectual as it would seem to be theoretically. A flock of poultry turned into the field would lessen the numbers of the worms somewhat.

However, the worms can be prevented from entering other fields, and may, in many cases, be checked and killed even after they have entered a new field ; in some cases, especially in corn fields, an advancing army may be stopped in the middle of the field and thus half of the crop saved. The simplest and most effectual method of doing this is to either dig a smooth-walled ditch, or plow several deep parallel furrows in front of the invading army ; the perpendicular, smooth side of the plowed furrow should be towards the field to be protected. The worms not being readily able to scale the perpendicular wall of the ditch or furrow will drop back and begin crawling along the bottom seeking an easier place of ascent. If deep holes have been dug in the ditch or furrow at intervals of a few feet, the worms,

---

*We bred several specimens of *Meteorus hyphantriae* Riley from army-worms. This insect and its curious suspended cocoons were illustrated on plate IV, *a*, *b*, *c*, of bulletin 123.

in their wanderings, readily tumble into these holes and cannot get out. Bushels of them have been trapped in this way, and then killed with a little kerosene or by burning some straw scattered along the furrow. The holes or pits in the furrows are very essential to the success of this preventive method. It has been aptly said : " To one who has never before seen the army-worm in its might, the sight of the myriads as they returned thwarted in their endeavors to cross a ditch or furrow, or of the living, moving, and twisting mass which sometimes fills a ditch to the depth of several inches, it is truly interesting." In some soils a little extra work will be necessary to keep one side of the furrow perpendicular and to keep the earth loose and friable in the furrow ; some accomplish the latter by dragging brush along the furrow. A ditch or several furrows well taken care of in this way will afford an almost impassable barrier to the worms, as many, who followed the directions carefully last year, can testify. It is such an easy matter to make a furrow and as one is not so effectual a barrier as a ditch, we advise that two or more parallel furrows be made, so that the worms which may scale the first one will be confronted by another.

A strip of coal tar will effectually stop the worms as long as it remains sticky, but it has to be renewed once or twice a day and is thus expensive. There were some reports that the worms would not cross a strip of salt, and that when sprinkled with salt they die. Mr. Wm. R. Huntington, Rome, N. Y., reported to us the following experiment with salt: " After hearing that salt would kill them, I took a pailful and went into a corn field where there were lots of worms. I found some on the ground and put salt all around them and on them. They would curl up and after a short time, a minute or two, would crawl away as lively as ever. I next went to some hills of corn that were badly eaten and covered with worms. I put at least a handful of salt on a number of such stalks, covering up many of the worms, but I could not see that it had any effect upon them. The next day I found the same worms, apparently, eating close to the salt. I had already put a ditch around this piece which held them where they were, so I did not experiment any farther with salt, not having any faith in it." Whenever practicable, it is always a good plan to make a

ditch or furrows around the whole field or the worst infested section of the field and thus confine the worms as Mr. Huntington did. Then turn in your poultry or poison the worms. Our little parasitic friends often do noble work in checking the future development of the insect, but they do not give the immediate relief which the farmer usually needs.

When the worms can be confined to a small area by a ditch, it may be practicable to spray this area with a strong Paris green mixture to poison the worms. Sometimes much can be done to lessen their numbers by drenching with Paris green a narrow strip of the crop on the side toward which the army of the worms are marching, or even a strip just ahead of the worms in an infested field. A bran mash, to which enough Paris green has been added to give it a distinct greenish tinge, scattered about where the worms are at work will attract and poison many of them.

In fighting army-worms, it is necessary to act quickly, for a day's delay often means the destruction of an acre or more of a promising rye, corn, oat, or hay crop. Stop the onward progress of the worms, or confine them in a limited area if practicable, with ditches or deep furrows in which holes have been dug every 10 or 15 feet. Then kill as many of the worms as possible, either in the holes in the furrows, or by the use of poisons, or invite the poultry to a feast.

MARK VERNON SLINGERLAND.

Bulletin 134. April, 1897.
Cornell University Agricultural Experiment Station.
ITHACA, N. Y.
HORTICULTURAL DIVISION.

Strawberries under Glass.

By C. E. HUNN and L. H. BAILEY.

PUBLISHED BY THE UNIVERSITY,
ITHACA, N. Y.
1897.

ORGANIZATION.

BOARD OF CONTROL:

THE TRUSTEES OF THE UNIVERSITY.

STATION COUNCIL.

President, JACOB GOULD SCHURMAN.

Hon. A. D. WHITE,	Trustee of the University.
Hon. B. F. TRACY,	President State Agricultural Society.
Professor I. P. ROBERTS,	Agriculture.
Professor G. C. CALDWELL,	Chemistry.
Professor JAMES LAW,	Veterinary Science.
Professor J. H. COMSTOCK,	Entomology.
Professor L. H. BAILEY,	Horticulture.
Professor H. H. WING,	Dairy Husbandry.
Professor G. F. ATKINSON,	Botany.

OFFICERS OF THE STATION.

I. P. ROBERTS,	Director.
E. L. WILLIAMS,	Treasurer.
E. A. BUTLER,	Clerk.

ASSISTANTS.

M. V. SLINGERLAND,	Entomology.
G. W. CAVANAUGH,	Chemistry.
L. A. CLINTON,	Agriculture.
B. M. DUGGAR,	Cryptogamic Botany.

Office of the Director, 20 Morrill Hall.
The regular bulletins of the Station are sent free to all who request them

BULLETINS OF 1897.

CORNELL UNIVERSITY, ITHACA, N. Y.,
April 23, 1897.

HONORABLE COMMISSIONER OF AGRICULTURE, ALBANY :

Sir: The ensuing paper is submitted for publication under Chap. 437 of the Laws of 1896.

The bulletins which have been issued under the Experiment Station Extension Bill have been of four general types,—those which have attempted to improve the cultivation of staple or well known crops, which have endeavored to interest the farmer in the amenities of rural life (as the flower and tree-planting bulletins), those which aim to expound well known facts and principles, and those, like the present, which suggest new avenues of profit. There of are, of course, no hard and fast lines dividing these classes of bulletins, and it is hoped that the total effect of them has been educative. The writer will be glad if they have opened new and pleasant lines of thought to the dweller in the country, and have thereby given him any new incentives to live and work.

Several years ago, the writer undertook the investigation of the winter forcing of vegetables, and whilst that type of experiment is not to be discontinued, it is nevertheless to form a very subsidiary part of the work in the next few years. That ground has been fairly well traversed. He now drops the Experiment Station Extension work by suggesting a new field of experiment,—the winter forcing of fruits.

L. H. BAILEY.

73.—*Bench of Beder Wood strawberries, in 6-inch pots. Berries supported by sections of wire screen. See, also, the picture on the title-page.*

STRAWBERRIES UNDER GLASS.

During the past winter we made an attempt upon a considerable scale to grow strawberries under glass. The attempt was so successful that the methods which were employed in the raising of the crop are here detailed. The experiment was made under difficulties from the fact that we have no house especially adapted to the purpose, the climate of Ithaca is excessively cloudy,* and we also had no well-established strawberry plants of the varieties which we desired from which young plants could be raised. Consequently the berries were grown in two houses which were too high and rather too dark for their best development; and the plants were taken from stock which was set late in the spring of 1896. It is probable that best results are to be secured from runners of maiden plants which are set very early in the spring or in the fall before.

The stock plants from which runners were taken were set on the 6th of May in rich and mellow ground, but the season turned out to be very dry and the plants made less growth than they would have made in a normal season. Three lots of plants were grown from this stock, as follows: The first lot was grown in 2½ inch pots plunged under the runners on July 10th; the second lot was from pots plunged on July 27th; and the third from those plunged on August 22d. After having grown in these pots for a period of about two weeks, the plants were taken up and shifted into 4-inch pots and were then put in frames. The frames which we used for this purpose were simply common cold-frames, upon which no glass was placed until very cold weather came on.

The first lot of plants was taken to the frames on the 24th of July; the second upon the 21st of August; and the third lot upon the 11th of September. The plants were shifted again into 5-inch and finally into 6-inch pots, and in the latter size they were

* From December 1st to February 1st there was not a full day of clear sunshine.

brought into the forcing-houses and carried through to fruiting. The first lot was shifted from fours to fives on the 8th of September, and from fives to sixes on the 26th of September; and the other lots received similar treatment.

The plants were allowed to remain out of doors until nearly mid-winter, with no more protection than a covering of glass during the very coldest times. It was the desire to give them a very thorough rest by allowing them to freeze perfectly solid. We are not at all sure that this freezing is essential. In fact, the probability is that berries can be raised about as well without it; but it is very probable that a decided check or rest to the plants before they are taken to the houses will add greatly to their productiveness and strength, and freezing may be expected to destroy red spider and other pests.

On the 28th of December, 450 pots of the first lot were brought into a house which had a temperature of 40 to 45 degrees at night. All dead and diseased leaves were trimmed away. On the 6th of January, the young leaves had begun to appear freely and now and then there appeared a spot of the rust. They were then thoroughly sprayed with the ammoniacal carbonate of copper and after that time the disease made no trouble. The house was vaporized at frequent intervals with the Rose Leaf extract of tobacco in order to keep down insects.

Many flowers were open on the first of February. On the 9th, the pots were transferred to a warm house (temperature of 65 degrees at night), and the plants were staged near the glass, and were allowed to remain until the fruit was off (Fig. 73).

Upon the 6th of March, the berries were well colored, and the first picking was made on the 11th, when they sold in Ithaca for $2 per quart. The crop continued for about ten days.

The Beder Wood comprised the greater part of the pots of this first lot. They came into bloom when the foliage was still very small and scant, and we were fearful that there would not be foliage enough to carry the plants to maturity; but this fear proved to be groundless. It was observed that when the weather was very cloudy and damp, the stamens did not develop strongly and there was much difficulty in getting sufficient pollen to pollinate the flowers. The Beder Wood is a perfect-flowered berry, but we

found that it produced only sufficient pollen for itself. This pollen was transferred upon every bright day by means of a brush. A soft brush was rubbed over the anthers and the pollen thereby taken off, and then the brush was rubbed over the pistils (or the center of the flower). The operator always carried with him a little spoon-like implement, which is made by gluing a watch-crystal upon the end of a small ladle,* and whenever any flower contained a superabundance of pollen, the dust was shaken into this receptacle and used for those flowers in which the pollen was deficient. A common spoon would answer this purpose very well. It is necessary to repeat the pollinating every pleasant day. As in the case of tomatoes and other hot-house plants, the pollen is discharged most freely when the sun is warm and bright and when the house is dry. It is very essential that pains be taken to completely pollinate every flower, for if one side of the head of pistils is left unfertilized, that side of the berry will fail to develop and a nubbin will be the result.

Upon the 19th of February, when the berries were well set, liquid manure was first given to the plants; and the application was repeated twice a week until the berries were about full grown.

It is necessary to devise some means to hold the berries up from the earth or the pot, otherwise they are likely to decay in the humid atmosphere of the house, and they become soiled in watering. Our first effort was to cover the tops of the pots with sphagnum moss, but two or three days of dull wet weather brought on indications of the rot, and the moss was quickly removed. Some of the pots were then covered with cork dust, such as is used in the packing of foreign grapes, and this answered the purpose most admirably; but it is not always handy to get and it is some trouble to apply it and to keep it clean. The next attempt was the use of small pieces of fine wire screen, such as is shown in the illustrations, and this was a most admirable success. It kept the berries away from the earth and showed them off to the very best advantage. Forked sticks are sometimes used for this purpose.

The second lot of plants was brought in from the frames upon the 4th of February and placed upon a work-room floor where

* Figured in "The Forcing Book," Fig. 53.

the pots could gradually thaw out. Upon the 9th, they were placed upon the benches in a house with a temperature of 40-45 degrees at night, and thereafter they were treated in the same manner as those in the first lot. The third lot was handled in essentially the same way. In the second and third lots were a number of other varieties, of which the Sharpless and Van Deman were the most prominent. There were also a few Hunn. The best results were obtained with the Beder Wood, and this is the variety which is shown in Fig. 73 and also upon the title-page. One of its strong peculiarities is the comparatively small amount of foliage which it bears and the consequent greater prominence of the fruit. Its chief drawback is the light color of the berries. In respect to color, the Van Deman is somewhat better, but the habit of the plant is more tall and less attractive ; and although it is a perfect-flowered berry, we had difficulty in securing enough pollen to fertilize it. Its great merit for a forcing berry is its earliness. Sharpless is about ten days later than Van Deman, and Hunn is at least two weeks later. This last is the handsomest berry which we have had in the house, being very large and exceedingly dark colored ; but it is much too late to be profitable for forcing.

The first crop of Beder Wood averaged six first-class and uniform fruits to a plant in the whole lot of over four hundred pots. The plants set from eight to twelve berries each, but the small and imperfect ones were cut off and the limit was fixed at about eight fruits. We are now convinced that if we could have had stronger plants to start with, and with the experience of the present winter, we could average eight fruits to the plant. At this writing (April 23), the Beder Woods of the third lot are setting their fruits freely and no hand pollination is given them. The workman simply brushes his arm over the plants whenever he passes along, and the pollen seems to have disseminated itself freely. At this time of the year, however, the houses are open and dry so that the pollen is discharged much more freely than it is in the winter time.

Because the pots are set so close together in the house, it is possible to secure a larger yield per square foot under glass than is obtained in the field. In our experience, eight to twelve pots

give a quart of berries. That is, a quart is obtained from two to three square feet of floor space. Allowing for walks and unavoidable waste space, the yield would still figure up fully 400 bushels to the acre.

In regard to the demand for house-grown strawberries, we can give very little information. It is the province of an Experiment Station to determine how plants may be grown rather than to determine how they may be sold. In the larger cities, however, there is always a limited but brisk demand at high prices for winter-grown berries. The price ranges from four to even five dollars a quart down to two dollars and a dollar and a half. A well-grown pot of strawberries is one of the most interesting plants for table decoration and there is a considerable market for the plants in this condition. Late in April we saw six-inch pots of strawberries upon sale in a small city market for fifty cents each, none of which bore more than two or three ripe fruits, and even those were of very indifferent quality. With pots bearing from six to eight large and evenly ripened fruits, there should be no difficulty in realizing from one to two dollars a pot. The following note from *Garden and Forest* will bear out this statement:* "Pots of fruiting strawberry plants were an attractive Easter specialty in a fruiterer's window on Broadway last week. The foliage was fresh and luxuriant, with three or four large highly colored ripe berries and a few immature ones. The plants sold for $1.50 to $2.50 each."

In all our experience in the growing of plants, we have never aroused so much enthusiasm from plant lovers as with the strawberries; and it is difficult to conceive how any object can be better suited to the finest table decoration than a clean pot with a thrifty and well formed strawberry plant bearing six to eight full ripe berries and a few blossoms.

Some of the points in the cultivation of strawberries under glass which appeal to us with especial force are these:

1. Very strong plants to begin with, which have been kept in vigorous growth, and not allowed to become pot-bound until they have reached six-inch pots.

---

* *Garden and Forest*, x. 160 (April 21, 1897).

2. Varieties which are early, or at least not later than mid-season, and preferably those which themselves produce an abundance of pollen.

3. The exercise of great care to have the plants free of fungous diseases and insects before they are put upon the benches.

4. The devoting of an entire house to the crop. If two or three different crops are grown in the same house, none of them can receive the very best treatment which they demand; and if there are other plants in the house which are infested with red spider, the pests will spread to the strawberries and it is very difficult to dislodge them without keeping the plants so wet that pollination is interfered with and rot threatened.

5. Growing the plants as close to the glass as possible.

6. In the dull months, constant and careful attention to hand pollination.

7. Liberal applications of liquid manure two or three times a week after the fruits have begun to swell.

8. Exercise of care that the berries do not lie directly upon the soil or upon a wet surface.

We are by no means confident that we have found the best methods of forcing strawberries. We give our experience for what it is worth, and desire to correspond with persons who can help us to better results.

C. E. HUNN.

L. H. BAILEY.

Bulletins of Cornell University Agricultural Experiment Station,

1888 to Aug. 1, 1897.

* 1 Experimental Dairy House
* 2 Feeding Lambs for Fat and Lean
* 3 Insectory of Cornell Univ. Wireworms
* 4 Growing Corn for Fodder and Ensilage
* 5 Lean Meat in Mature Animals
* 6 Fodders and Feeding Stuffs
* 7 Influences Affecting Sprouting of Seeds
* 8 Different Rations for Fattening Lambs
* 9 Windbreaks in their Relation to Fruit
*10 Tomatoes
*11 Saw Fly Borer in Wheat
*12 Apparatus for Drying in Hydrogen and Ex. Fat
*13 Leaching of Farm-yard Manure
*14 Strawberry Leaf Blight
*15 Sundry Investigations of 1889
*16 Growing Corn for Fodder and Ensilage
*17 Cochran's Method for Testing Milk
*18 Experiences in Spraying
*19 Condition of Fruit Growing in West. N. Y
*20 Cream Raising by Dilution
*21 Tomatoes
*22 Grain for Cows at Pasture
*23 Insects Injurious to Fruits
*24 Clover Rust
*25 Sundry Investigations of 1890
*26 Egg Plants
*27 Farm Manures
*28 Forcing Tomatoes
*29 Cream Raising by Dilution
*30 Influence of Electric Light on Greenhouse Plants
*31 Forcing English Cucumbers
*32 Tomatoes
*33 Wireworms
*34 Dewberries
*35 Combination of Fungicides and Insecticides
*36 Grain for Cows at Pasture
*37 Sundry Investigations of 1891
38 Native Plums and Cherries
39 Creaming and Aerating Milk
40 Removing Tassels from Corn
41 Steam and Hot Water for Heating Greenhouse
*42 Electro Horticulture
*43 Trouble of Winter Tomatoes
*44 Pear Tree Psylla
*45 Tomatoes
*46 Mulberries
*47 Feeding Lambs and Pigs
*48 Spraying Apple Orchards
49 Sundry Investigations of 1892
*50 The Bud Moth
*51 Four New Types of Fruit
*52 Cost of Milk Production
53 Ædema of the Tomato
*54 Dehorning
55 Greenhouse Notes
*56 The Production of Manure
*57 Raspberries and Blackberries
58 Four-Lined Leaf-Bug
59 Does Mulching Retard Maturity of Fruits
*60 The Spraying of Orchards
61 Sundry Investigations of the Year
*62 The Japanese Plums in North America
*63 Coöperative Test of Sugar Beets
64 On Certain Grass-Eating Insects
*65 Tuberculosis in Relation to Animal Industry
*66 Test of Cream Separators
*67 Some Recent Chinese Vegetables
*68 The Cultivated Poplars
*69 Hints on the Planting of Orchards
*70 The Native Dwarf Cherries
71 Apricot Growing in Western New York
72 The Cultivation of Orchards
73 Leaf Curl and Plum Pockets
74 Impressions of the Peach Industry in N. Y.
75 Peach Yellows
76 Some Grape Troubles in Western N. Y.
77 The Grafting of Grapes
78 The Cabbage Root Maggot
79 Varieties of Strawberry Leaf Blight
80 The Quince in Western N. Y.
81 Black Knot of Plums and Cherries
82 Experiments with Tuberculin
83 A Plum Scab in Western N. Y.
84 The Recent Apple Failures in N. Y.
*85 Whey Butter
86 Spraying of Orchards
87 Dwarf Lima Beans
88 Early Lamb Raising
*89 Feeding Pigs
90 The China Aster
91 Recent Chrysanthemums
92 Feeding Fat to Cows
93 Cigar-Case-Bearer
*94 Damping Off
95 Winter Muskmelons
96 Forcing House Miscellanies
97 Entomogenous Fungi
98 Cherries
99 Blackberries
100 Evaporated Raspberries in New York
101 The Spraying of Trees and the Canker Worm
102 General Observations in Care of Fruit Trees
103 Soil Depletion in Respect to Care of Fruit Trees
104 Climbing Cutworms in Western N. Y.
105 Test of Cream Separators
106 Revised Opinions of the Japanese Plums
107 Wireworms and the Bud Moth
108 The Psylla and N. Y. Plum Scale
109 Geological History of the Chautauqua Grape Belt
110 Extension Work in Horticulture
111 Sweet Peas
112 The 1895 Chrysanthemums
113 Diseases of the Potato
114 Spraying Calendar
115 The Pole Lima Beans
116 Dwarf Apples
117 Fruit Brevities
118 Food Preservatives and Butter Increasers
119 Texture of the Soil
120 Moisture of the Soil and Its Conservation
121 Suggestions for Planting Shrubbery
122 Second Report upon Extension Work in Horticulture
123 Green Fruit Worms
124 The Pistol-Case-Bearer in Western N.Y.
125 A Disease of Currant Canes
126 The Currant Stem Girdler and the Raspberry-Cane Maggot
127 A Second Account of Sweet Peas
128 A Talk About Dahlias
129 How to Conduct Field Experiments with Fertilizers
130 Potato Culture
131 Notes upon Plums
132 Notes upon Celery
133 The Army-worm in New York
134 Strawberries under Glass
135 Forage Crops
136 Chrysanthemums
137 Agricultural Extension Work, sketch of its Origin and Progress

* Out of Print.

Bulletin 135. May, 1897.

Cornell University Agricultural Experiment Station,

ITHACA, N. Y.

AGRICULTURAL DIVISION.

Forage Crops.

By I. P. ROBERTS and L. A. CLINTON.

PUBLISHED BY THE UNIVERSITY,
ITHACA, N. Y.
1897

ORGANIZATION.

BOARD OF CONTROL:

THE TRUSTEES OF THE UNIVERSITY.

STATION COUNCIL.

President, JACOB GOULD SCHURMAN.

Hon. A. D. WHITE,	Trustee of the University.
Hon. B. F. TRACY,	President State Agricultural Society.
Professor I. P. ROBERTS,	Agriculture.
Professor G. C. CALDWELL,	Chemistry.
Professor JAMES LAW,	Veterinary Science.
Professor J. H. COMSTOCK,	Entomology.
Professor L. H. BAILEY,	Horticulture.
Professor H. H. WING,	Dairy Husbandry.
Professor G. F. ATKINSON,	Botany.

OFFICERS OF THE STATION.

I. P. ROBERTS,	Director.
E. L. WILLIAMS,	Treasurer.
EDWARD A. BUTLER,	Clerk.

ASSISTANTS.

M. V. SLINGERLAND,	Entomology.
G. W. CAVANAUGH,	Chemistry.
L. A. CLINTON,	Agriculture.
B. M. DUGGAR,	Cryptogamic Botany.
A. L. KNISELY,	Chemistry.

Office of the Director, 20 Morrill Hall.
The regular bulletins of the Station are sent free to all who request them.

BULLETINS OF 1897.

124. The Pistol-Case-Bearer in Western New York.
125. A Disease of Currant Canes.
126. The Currant-Stem Girdler and the Raspberry-Cane Maggot.
127. A Second Account of Sweet Peas.
128. A Talk about Dahlias.
129. How to Conduct Field Experiments with Fertilizers.
130. Potato Culture.
131. Notes upon Plums for Western New York.
132. Notes upon Celery.
133. The Army-worm in New York.
134. Strawberries under Glass.
135. Forage Crops.

FORAGE CROPS.

There has within recent years been an increasing demand for information concerning forage crops. With many, meadows and pastures have proven insufficient to meet the demands made upon them and it has become a serious question as to the best manner for supplying the deficiency. The causes of the deficiency are various and far reaching but the results are the same. Especially in the dairy sections has the failure been most keenly felt and there has arisen a demand for information concerning forage and soiling crops.

Many successful farmers of the state who have practiced soiling, the growing of crops to be cut and fed green, have found the plan more satisfactory than depending entirely upon pastures, and the soiling system with them has become firmly established. Much of the land which has for years been devoted to permanent pasture or permanent meadow has ceased to be profitably productive, and where the tillage of such lands is practicable, ordinarily better returns would be secured were they devoted to the production of special forage crops. Short rotations and intensive agriculture must largely take the place of the permanent meadows and pastures where the land has been allowed to remain in sod year after year until the moss and the daisies have so taken possession that the fields looks more like huge flower beds than grass plats. Hardly a summer passes during which droughts more or less severe are not experienced. The effect of these droughts is always seen most quickly on the meadows and pastures and when this is observed there should be immediately available some forage crop which can be drawn upon to tide the stock over the dry time and give the pastures opportunity to recover. This is especially important in the dairy sections of the state where the milk supply should be kept up, no matter what the conditions of the weather. For the past few years the horn fly has been such a pest at times that some have adopted the practice of blanketing their cows to protect them

from the ravages of the fly. Unless protected in some way cows frequently fall off in milk production from fifty to seventy-five per cent. It is not only humane, but it is a wise financial policy to keep the cows stabled at least a portion of the day where it is shaded and cool, that they may be fed upon some freshly cut succulent forage provided for the purpose. Where cared for in this way they will usually respond abundantly and repay the extra labor involved.

That farm practice which necessitates that well bred animals designed for the production of milk should be compelled to work ten hours a day in order to get from the meagre pastures enough for a mere subsistence is radically wrong. A far better plan is to provide green forage so that during the hottest days the feeding may be done, at least in part, where the animals can eat with some degree of comfort and not be required to expend their energy in fighting the flies or in roaming over brown and parched pastures seeking for that green morsel which is not there and which the thoughtless owner has failed to provide.

Those crops which have proven themselves with us most successful as producers of forage are

Corn.
Oats and peas.
Oats.
Barley and oats.
Rye.
Barley.
Millets and Hungarian.

From the fact that so many queries are being constantly received with reference to the production of forage it has been thought wise to go somewhat into detail with the hope that the information given might prove of value.

CORN AS A FORAGE CROP.

Where corn can be successfully grown it stands preëminent as a producer of forage and should have a prominent place in the rotation on every stock farm. Though some of the other crops mentioned later may serve better for early forage, yet for late summer or fall there is no crop which can compare with corn either in

amount of produce or feeding value. By the introduction of the silo it is now possible to produce milk as cheap or cheaper during the winter than during the summer. By the more general use of forage and soiling crops it will be possible to lessen materially the cost of production of milk in summer. Though corn is one of the most common of our farm crops, yet there are some facts with reference to its nature and production about which it may be well to speak somewhat in detail.

History of the Plant.

Corn is a sub-tropical plant and is supposed to have had its origin in Mexico. It loves a warm summer climate and a warm porous soil and grows to perfection only in the presence of sunlight and warmth. Corn is the richest gift of the new world to mankind, and even with the adverse conditions under which it is so often raised its value in America far exceeds that of any other crop grown.

Soil for Corn.

Owing to the sub-tropical nature of the plant, that soil is best suited for the growth of corn which is well drained, loose and fairly porous but not leachy. A loamy soil with a clay subsoil presents almost ideal conditions. The plowing should be so done that the soil is well pulverized and the furrow slice left somewhat on edge, not completely inverted. Where sod land is plowed the jointer attachment should always be used that the tenacity of the sod may be broken up. The placing of the furrow upon edge and allowing it to remain for a few days before harrowing down gives chance for aeration and warming, both of which are prime requisites for success in corn raising. While a fairly fine seed bed is important, yet only so much harrowing as is necessary to produce it should be given. In fitting the land for wheat the sub-surface soil may be somewhat firmly compacted. A firm, compact sub-surface soil and a loose surface mulch present the ideal conditions for wheat, and the tramping and packing of the horses feet may do as much or more good than the harrowing. But with corn different soil conditions are required, and unless necessary in order to improve the texture of the soil, the fitting should be somewhat superficial, for if much harrowing be done, this, with

the packing which the soil must receive in after tillage, will so compact the sub-surface soil that harmful conditions will be produced.

Planting of Corn for Forage and the Silo.

When the silo first came into general use it was believed that the corn with which to fill it should be planted thickly either in hills or drills and that the quality of the produce was in no way depreciated in value by being grown thickly. A too common practice now is to raise sowed corn, the claim being that it produces a larger amount of forage per acre and that though planted so thickly that no ears can form and mature, yet the valuable food constituents which would go into the ears if formed, in this case go into the stalks. Some of the most observing farmers have noticed that sowed corn is quickly affected by drought, that before growth is half complete the lower leaves are usually parched and burned. There are so many plants growing on the soil that the moisture supply is entirely inadequate to meet the demands being made upon it. As has been mentioned, corn is a sun plant and grow to perfection only when the sunlight permeates to every part of its structure and corn grown largely in the shade as is sowed corn, though it may produce a large gross amount, yet the product is deficient in those volatile oils which so largely determine the quality of the food. The protein, the most valuable constituent, is deficient as will be seen by reference to the table giving the analysis of corn.

During 1895 and 1896 experiments were conducted to determine the relative feed value of corn planted in hills, drills and sown broadcast. The variety of corn used was Sibley's Pride of the North. The soil was gravelly loam and had been for years subjected to a four years' rotation, consisting of wheat, meadow (clover and timothy), corn and oats. During the winter of 1893-4 the land was given a top dressing of stable manure, about ten tons per acre. In the spring of 1894 the land was fitted, and planted to corn. After the corn was removed the land was plowed in the fall and gang plowed in the spring and the three one twentieth acre plats to be compared were planted May 2 and 3, 1895 to Sibley's Pride of the North. Plat 31 was planted in rows 3¼ feet apart with hills 3½ feet apart in the row and 4 kernels to the

hill. Plat 32 was drilled in with a common grain drill, so arranged that the rows were 3½ feet apart while the broadcast conditions were obtained by drilling in the corn with all hose of the drill open and sowing at the rate of two bushels per acre. The yield from the various plats is shown in the following table :

TABLE SHOWING RESULTS FROM DIFFERENT METHODS OF PLANTING CORN, 1895.

Plat No.	Manner of planting.	Yield per acre. Pounds.		
		Stalks.	Grain.	Total.
31	Hills.	15,340	6,000	21,340
32	Drills.	20,240	6,400	26,640
33	Broadcast.	29,580	00	29,580

In 1896 the corn was planted similar to the way in which it was planted in 1895.

TABLE SHOWING RESULTS FROM DIFFERENT METHODS OF PLANTING CORN, 1896.

Plat No.	Manner of planting.	Yield per acre. Pounds.		
		Stalks.	Grain.	Total.
22	Hills.	18,800	5,280	24,080
23	Drills.	19,390	2,304	21,094
24	Broadcast.	29,591	00	29,591

If the investigation had stopped here the results would clearly have been in favor of the broadcast method of seeding. This is as far as the producer is able to get unless he is of an especially enquiring mind and conducts careful feeding experiments with an endeavor to find out from the animal which material is best. At the time the corn was in best condition for forage, samples were taken from each plat. On the plats of hilled and drilled corn the

sample included the stalk and the grain, while of necessity the sample from the plat of sowed corn was only of the stalk, there being little or no grain formed. Care was taken to have the sample from each plat a good average of the produce of the plat. The analysis was made from the 1895 crop and assumed to fairly represent the crop of 1896 grown under similar conditions.

The following table shows the average yield from the plats for the two years and the estimated food value of each product, the computations being made from the analysis of the 1895 crop.

A careful study of the table will reveal several things, which without the aid of the chemist might have passed unnoticed. While the plat of broadcast corn gave the greatest total yield per acre yet little or no grain was formed and the feed value was relatively less than on the plat of corn planted in hills. Though the column giving the estimated value per acre does not necessarily represent the true feeding value yet it does correctly represent the relative value. If the analyses had been carried still farther and the proportion of digestible nutrients determined there is but little question that a wider difference would have been shown in the actual feed value. Could the animal have been questioned as to which method of planting furnished the best fodder she would have spoken in unmistakable terms in favor of that corn which was grown in the open sunlight.

The following quotation from Bulletin 16, Cornell Experiment Station, may be found helpful to an understanding of the tables.

" It seems still necessary that an explanation of the terms used should accompany all discussions of foods and fodders, and we may therefore be pardoned for repeating it here.

The value of a fodder in the main depends upon the amount and relative proportions of four classes of constituents. These are usually denominated by chemists as crude protein (nitrogen multiplied by 6.25), ether extract, nitrogen-free extract, and fibre.

Protein is the most costly and the most valuable constituent of fodders. Protein substances contain nitrogen and are often called albuminoids or flesh formers. They are found in all parts of all plants and all animals, and are important and indispensable con-

CORN AVERAGE.*

RESULTS FROM DIFFERENT METHODS OF SEEDING FOR 1895 AND 1896.

Manner of planting.	Yield per acre.			Analysis.							Estimated value per acre. †
	Stalks.	Grain.	Total.	Moisture.	Dry matter.	Protein.	Fat or ether extract.	Nitrogen-free extract.	Fibre.	Ash.	
	Pounds.	Pounds.	Pounds.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	
Hills	17,070	5,648	22,718	68.67	31.33	2.83	.88	19.92	6.42	1.28	$73.31
Drilled	19,815	4,384	24,199	71.16	28.84	1.83	.68	18.13	6.94	1.26	$66.83
Broadcast.........	29,586	None	29,586	76.42	23.58	1.38	.60	14.04	6.37	1.19	$68.17

* The chemical work of this bulletin was done by Mr. Geo. W. Cavanaugh. The details of the field work in 1895 were conducted by Mr. Geo. C. Watson.

† Protein 2.3 cents per lb.; fat 1.14 cents per lb.; nitrogen-free extract and fibre 94 cents per lb.—*Conn. Exp. Station, 1893.*

stituents of lean meat, blood, and all internal organs. Since a large number of fodders are lacking in this class of constituents, the amount of protein that a fodder contains is largely a measure of its value.

Ether extract is mainly composed of fats and oils, and is usually spoken of as such. It is used by the animal as a heat producer or stored up in the tissues of the body as surplus fat. For these purposes it is worth nearly two and one-quarter times as much as starch, sugar, gum, and other carbhydrates.

Nitrogen-free extract consists of those substances containing no nitrogen that are soluble in water and dilute acids and alkalies; it is mainly made up of starch, sugar, and gum, and the whole class is often spoken of as carbhydrates. The functions of these carbhydrates in the animal economy is mainly that of heat and fat producers.

Fibre is that portion of the plant not dissolved by the action of dilute acids and alkalies. In composition it is a carbhydrate, and its function as a fodder is the same as the other carbhydrates, but being less digestible is of less value."

A most important element which enters into determining the feeding value of corn is the degree of maturity it reaches before being cut. It increases in value very rapidly as it approaches the period of maturity. In the case of corn planted in hills so that it can be given tillage the moisture may be conserved even during drought so that the corn is enabled to continue growth until it reaches maturity and posesses its greatest feeding value. With the sowed corn conditions are entirely different, for long before the time of maturity the corn has ceased growth because the moisture supply has been used up. In 1896 the corn on the broadcast plat was dry and parched ready for cutting August 14th. Before cutting the plat two rows were cut from the outside where the sunlight and moisture had been more abundant. The weight of the forage from the two rows was 330 pounds. On the same date two rows were cut through the center of the plat where sunlight had been excluded and moisture deficient and the total weight of the forage from the two rows was only 81 pounds. The whole plat of broadcast corn was cut August 14th in order to save it. The adjoining plat of drilled corn was suffering from drought and

was cut August 21. The adjoining plat of hilled corn showed no signs of wilting and continued its growth and development until time of cutting September 8th.

74.—*A corner of a Plat of Sowed Corn.*

The very rapid increase in feeding value of corn as it approaches maturity should be understood all by producers whether the product is to be used for silage or fodder. The importance of the subject leads us to republish a portion of Bulletin 16 of this Station in which the matter is clearly set forth.

The best period for cutting.

"As the results of analyses made at different periods of growth

in 1888 we strongly urged* that only such varieties of corn should be grown for ensilage as would reach a good degree of maturity in the locality grown. These conclusions have been abundantly confirmed, not only by our own experiments repeated in 1889, but by similar experiments at several other stations.

The variety used was the same as last year, viz.: Pride of the North of a strain that has been grown on the farm for several years and has become well acclimated. The soil was a clayey loam. It was in clover and timothy sod and had received a good dressing of farm-yard manure during the winter. The corn was planted in hills three feet three inches by three feet eight inches apart, and received ordinary cultivation.

The season was late and very wet. The corn was planted about May 12, and the first cutting was made on August 2, at which time it was just coming into blossom and was at the same degree of maturity, as well as could be judged, that it was in 1888 on July 24th. On Aug. 17th the second cutting was made, the kernels were just beginning to fill with milk. The corn matured much more slowly in 1888 than in 1889, and further cuttings were made on Aug. 31st and Sept. 10th, during the period of "roasting ear" condition. The final cutting of the mature corn was made on Sept. 24th, no frost having intervened. The corn at this cutting was perhaps a trifle more mature than it was in 1888 on Sept. 3.

The samples were taken as follows: At each cutting three average hills were selected and cut close to the ground. They were then treated in the same manner as the samples of the different varieties already described. The table below shows the percentage composition at the various periods. It will be noticed that the most marked difference is in the great increase in dry substance between Sept. 10th and Sept. 24th. It will also be noticed that there was more water on Aug. 17th than on Aug. 2d. This is entirely out of the usual experience and may perhaps be due to the individuality of the plants sampled. In regard to the dry substance we find, as is usual, that the per cent of protein gradually diminishes and of carbhydrates and fibre increases as development approaches maturity.

---

* Bulletin No. 4. Cornell University Agricultural Experiment Station, p. 52.

TABLE IV.

DATE OF CUTTING.	STAGE OF MATURITY.	Water Per Cent.	Dry Matter Per Cent.	In the Dry Matter. Crude Protein Per Cent.	Ether Extract (fat) Per Cent.	Nitrogen-Free Extract (carbhydrates) Per Cent.	Crude Fibre Per Cent.	Ash Per Cent.
Aug. 2......	In Bloom.	85.25	14.75	9.87	2.68	58.07	22.06	7.32
Aug. 17....	In Milk.	87.31	13.69	9.03	1.71	57.74	25.11	6.41
Aug. 31....	Roasting	82.56	17.44	8.84	1.96	55.21	28.43	5.56
Sept. 10....	Ear.	81.37	18.63	6.17	2.43	59.06	27.19	5.15
Sept. 24 ..	Mature.	69.75	30.25	7.53	2.46	61.46	25.05	3.50

At each period of cutting, except the last, besides taking the sample, there were cut and weighed sixty hills of corn. The weight of the corn so cut was used as a basis for computing the yield of green fodder and of the various constituents per acre, except in the cutting of Sept. 24, when a measured acre was cut and weighed. These results are shown in the table below.

TABLE V.

DATE OF CUTTING.	STAGE OF MATURITY.	Yield in Pounds Per Acre. Green Forage.	Per Cent. Water.	Dry Matter.	Crude Protein.	Ether Extract.	Nitrogen Free Extract.	Crude Fibre.	Ash.
Aug. 2.......	In Bloom.	24805	85.25	3658	361	98	2124	807	268
Aug. 17.....	In Milk.	27830	87.31	3810	344	6 5	2200	957	244
Aug. 31.....	Roasting	30250	82.56	5274	467	103	2912	1499	293
Sept. 10.....	Ear.	28980	81.37	5398	333	133	3188	1466	278
Sept. 24.....	Mature.	30108	69.75	9109	686	224	5598	2282	319

It will be seen that between the first and last cutting the dry matter and carbhydrates increased about 150 per cent, the fat about 125 per cent and the protein nearly doubled. In our experiments last year* we found that the total feeding value, in the period between tasseling and ripening, increased 166 per cent, so that the experiments of this year confirm those of last.

Further than this, investigations at three other experiment stations have been made in almost exactly the same way and the results of all agree. These experiments in brief are as follows:

In 1887 Professor Whitcher, of the New Hampshire Agricultural Experiment Station, made analyses of four different varieties at four stages of growth.† The four varieties were a southern ensilage corn, a northern flint corn, Sanford (flint), and Pride of the North (dent). The cuttings were made July 26, Aug. 5, Aug. 19, and Sept. 16. At the first date none were in tassel but the northern flint; at the last date the northern flint was completely ripe, the Sanford and Pride of the North were nearly mature, and the kernels of the southern ensilage were just blistering. Between Aug. 5th, at which time but one of the varieties had passed the blossoming stage, and Sept. 16th, there was an increase in dry matter of 112 per cent, in albumenoids of 50 per cent, in fat of 84 per cent, and in carbhydrates of 130 per cent.

In 1888, at the Pennsylvania Agricultural Experiment Station, Mr. Caldwell found‡ that between the period of tasseling and complete ripeness there was an average gain of dry matter of 155 per cent. Ten varieties of corn (dents and southern ensilage corn) were used. Only the dry matter was determined. The dates of cutting are not given, and the last determination was made from the ears and stover cut and shocked as for grain.

In 1889, at the New York Agricultural Experiment Station, a very thorough investigation of this subject was made by Mr. Ladd, chemist of the station.|| The variety used was King Philip; the dates of cutting were July 30, Aug. 9, Aug. 21, Sept. 7, and Sept. 23, at which dates the condition of maturity was, re-

* Cornell University Agricultural Experiment Station Bull. 4. p. 52.

† New Hampshire Agricultural Experiment Station Bull. No. 3.

‡ Pennsylvania Agricultural Experiment Station Bull. 7, p. 7

|| New York Agricultural Experiment Station 8th Ann. Rept. p. 86.

spectively, tasseled, silk, in milk, glazed, and ripe. The computations were in each case based of the yield on a plot of a fifth of an acre so taken as to represent the average of a field of twelve acres. Between the first and last period there was an increase in dry matter of 389 per cent, of albumenoids of 183 per cent, of fat of 335 per cent, and of carbhydrates of 462 per cent.

In the above only the gain between the first and last periods is given, but the details show that the gain is continuous from period to period, and in general most rapid toward the last.

The results of all these experiments unite to show that there is a large increase of all the classes of nutrients as the corn proceeds from tasseling to ripeness.

It would seem as though the question of the proper time to cut corn for ensilage was definitely settled by these experiments. An increase of more than two hundred per cent between the periods of bloom and ripening cannot be ignored even though the proportion of the more valuable albumenoids is somewhat lessened. What gives the matter additional strength is that these experiments, including all the work so far done in this direction that has come to our notice, are unanimous in their conclusions."

The conclusions reached in the bulletin just quoted have in no way been disproven but have been amply confirmed by later experiments of this and other stations.

OATS AND PEAS AS FORAGE.

Ranking next to corn as a forage crop and a close second, comes oats and peas. In the two years in which we have been conducting experiments in the production of forage this combination has proven itself well worthy of a place on every farm where stock is kept. It is valuable either for pasture, for cutting as a soiling crop, or when allowed to mature it may be cured for hay, making a most valuable article. When planted in succession of about two weeks, the first planting being as early in the spring as conditions will permit, a succession of highly nutritious forage is produced which is greatly relished by stock. If a more general use was made of oats and peas for summer feeding it would

greatly decrease the expense of the production of milk and the cost of maintaining cattle and economize land very materially. A highly nutritious forage would be obtained, rich in protein and furnishing nearly a balanced ration for milch cows. A large amount can be produced per acre and it may be grown from early spring to late fall. A slight freeze does not affect it, and it may be sown in the spring before frosts are over and the late forage frequently remains in good condition until December. The oats and peas at this station sown August 1st, 1896, were in good condition for feeding until a severe freeze on the night of December 2d cut them down. For late forage, however, barley and peas are recommended instead of oats and peas. For sowing any time after July 1st substitute barley for oats. The reason for this is that in late summer barley makes more rapid growth, is less likely to attacks of rust and other fungous diseases than are oats. Figure 77 shows the relative growth of oats and barley in late summer, the tall plants being barley the shorter ones oats, seed for which was sown August 1st and photograph taken in late October.

Preparation of Soil for Oats and Peas.

This crop loves a mellow, loamy soil but will grow fairly well on soils ranging between heavy clay and sand and produce liberal returns. For early forage land should be selected which is moderately open and porous so that the plowing may be done early. Those soils containing a comparatively large percentage of clay can better be used where late forage is desired. Land should be plowed deep and in cases where sod is inverted the jointer should be used.

Method of Seeding.

While the land is still rough as left by the plow the peas should be sown broadcast at the rate of about one bushel per acre. Then the harrow should be used and the land thoroughly fitted and fined for oats. This fitting will cover the peas deeply and well, and it is to secure this deep covering that the peas are sown directly after the plow. Oats may then be sown broadcast or drilled in the ordinary way, using one bushel to one and a half bushels of seed per acre. If the soil is somewhat porous, sandy or gravelly, the

roller may follow the seeding. But should there be a somewhat large per cent of clay in the soil then the rolling would better be deferred until the young plants are two or three inches high, when the roller can be used without danger of producing injurious soil conditions due to packing. In six to eight weeks from time of sowing, with favorable conditions, cutting may begin though the greatest feed value is not reached until the time the grain is well in the milk stage. The commencement of cutting, however, should not be delayed until that time for, if there is any considerable area to be fed, the forage will have become too hard and woody before all of it can be used to advantage. Commence cutting or pasturing at or before the time of blossoming and continue through the milk stage. If the area is greater than can be advantageously used for forage and it is desired to cure a portion of it for hay, then the cutting should be done when well in the milk stage. It makes such a heavy growth and contains such a large percentage of water that some difficulty is occasionally experienced in the curing.

In our efforts to determine the relative value of some of the more common forage crops an experiment has been conducted for two years, during 1895 and 1896. In 1894 a crop of corn was grown on the land which had received during the previous winter a small dressing of barn manure. The size of plats was one-twentieth of an acre. At the time the grain was in the best apparent condition for forage, one-half of each plat was cut and weighed and a sample taken and analyzed. The other half was allowed to mature the grain, when it was cut and threshed, and the weight of grain and straw determined. The feeding value of the forage was determined from the sample taken when the first one-half of the plat was cut and all results as to yield and value are calculated per acre.

75.—*View of Plats, one-half of each plat has been cut for forage.*

PRODUCTION OF FORAGE 1895. ALL PLATS SOWN APRIL 24.

Plat No.	Grain sown.	Date of cutting forage.	Weight of forage per acre.	Date of cutting ripe grain.	Amount of grain per acre. Bushels	Weight of straw per acre.
42	Oats and peas	July 16	21,600	Aug. 3	85	5,280
43	Oats and barley	July 5	16,800	Aug. 3	82.5	3,760
44	Barley	June 29	11,600	July 23	55.6	4,080
45	Oats.	July 11	10,480	Aug. 3	50.6	3,580

PRODUCTION OF FORAGE 1896. ALL PLATS SOWN APRIL 20.

Plat No.	Grain sown.	Date of cutting forage.	Weight of forage per acre.	Date of cutting ripe grain.	Amount of grain per acre. Bushels.	Weight of straw per acre.
35	Oats, Am. Banner	June 30	14,080	July 22	56	4,200
36	Oats and barley	June 30	11,200	July 22	65	3,400
37	Oats and peas	July 1	26,000	July 22	49	2,360
38	Oats, White Russ'n	June 30	15,200	July 22	72.5	3,680
39	Oats, White Russ'n	June 30	17,080	July 22	78.75	3,480
40	Oats, Am. Banner	June 30	16,080	July 22	97.5	4,880
41	Oats, Silver Mine	June 30	19,320	July 22	90	3,920
42	Oats and peas	July 2	26,000	July 22	43.5	4,400
43	Oats and barley	June 27	18,000	July 22	60	5,400
44	Barley	June 22	15,200	July 22	50	3,600
45	Oats, White Russ'n	July 1	19,200	July 22	52.5	5,320

FORAGE CROPS.

Average Results 1895 and 1896. Calculated from the Analyses of forage made of 1895 Crop.

Crop planted.	Average yield per acre. Pounds.	Moisture. Per cent.	Dry matter. Per cent.	Analysis of dry matter. Protein Per cent.	Fat. Per cent.	Nitrogen-free extract. Per cent.	Fibre. Per cent.	Ash. Per cent.	Estimated value per acre calculated on dry matter.*
Oats and peas.	24,336	75.99	24.01	16.58	4.21	41.67	27.75	9.79	$63.11
Oats.	16,826	65.40	34.60	9.36	4.80	46.30	30.95	8.58	57.99
Barley and oats	15,333	65.59	34.41	10.14	4.36	49.28	28.92	7.30	43.39
Barley	13,400	77.01	22.99	11.33	2.07	50.32	29.92	6.36	31.99

* Protein 2.3 c. lb.; fat 1.14 c. lb.; nitrogen free; extract fibre .94.—*Conn. Exp. Sta. 1893.*

A careful study of the preceding tables will reveal several things. Though the estimated values given do not necessarily represent the actual feeding value, yet they do fairly show the relative value of the different crops for the production of forage. The unit of value used for the different constituents while not necessarily representing their value for all sections, does fairly represent their value for this state. The oats and peas are relatively rich in protein and ash elements. The protein is the most costly constituent which the New York feeder is called upon to provide, and it is this constituent which is most likely to be deficient in the ration. The ash constituent of a fodder is usually passed over without any comment, it being taken for granted that all fodders contain enough to meet the demands of the animal economy. But this conclusion is not based upon fact. The ash element of the fodder enters into the building up of the frame work of the body, the skeleton, and it is of the utmost importance that the mineral or ash material be present in liberal quantities. Oats and peas furnish a larger percentage of ash than any of the other forage crops grown by us and the importance of this, while not definitely known, is real and should not be overlooked.

76.—*Oat Field at Cornell University. Back part of Field being fitted for Wheat.*

A comparison of the tables showing the feeding value of corn and forage crops shows that of all varieties tested, corn is in the lead and that oats and peas come second. For variety of feed it would probably be advisable to have some plats of barley or of oats and barley combined, but the greatest returns with us were secured from corn and from oats and peas sown broadcast.

BARLEY AND PEAS.

While oats and peas are recommended for early forage, yet for late forage barley should be substituted for the oats. Figure 72 shows the relative growth of barley and oats in late fall. On August 1 the plats on which the forage crops were grown were all seeded to oats and peas. The volunteer barley which came up on the plats where barley had been grown grew much faster than the oats and was less affected by rust and drought.

Figure 78 shows the corner of a plat of oats and peas which was sown August 15. This was the third crop which had been grown on the ground during the season. Wheat which had been sown the previous fall was cut for forage when the grain was in the milk stage. The ground was then immediately plowed and sown to Hungarian grass on June 29. On August 11 the Hungarian was cut, producing five and one-half tons of green forage per acre. The ground was immediately plowed and on August 15 sown to oats and peas which were photographed in late October. They remained in good condition for forage until December 2.

Rye as a forage crop has to recommend it the fact that it is available for early spring use. As a cover crop it is becoming more general and for this purpose it is valuable. The land on which corn or potatoes have been grown should not be allowed to go into winter without some cover crop. Rye serves this purpose well and where so used it can be made to serve the double purpose of a cover crop and an early spring forage crop. After removing the rye in the spring the land may be utilized for the production of forage from oats and peas or for other crops.

HUNGARIAN AND MILLETS.

There are probably no crops grown for forage or for hay about which there are more inquiries than the Hungarian grass and the

77.—*Showing the relative growth of Barley and Oats for late forage.*

78.—*Plat of Oats and Peas grown for late forage.*

millets. No doubt they would be more extensively grown were their value and uses well understood. They are not recommended as being valuable as a part of the regular rotation, but as catch crops or special crops they have their place. They are very depleting to the soil and many have had unsatisfactory experience in feeding them to stock. Every farmer should have a knowledge of the proper use of the millets and of their place in the farm economy.

Hungarian grass is in most common use in the east, while in the west common millet and in the south German millet are more popular. One value of millet lies in the fact that it can be sown late, in fact must not be sown until all danger from frost is over. It develops rapidly and during midsummer is ready to begin cutting for forage about thirty days from time of seeding. The Hungarian is quicker maturing than the millets and for late sowing is preferable to either the common or the German millet. In such a year as 1894 or 1895, when many farmers found their hay crop a disappointment and were at a loss to know how to supplement it, Hungarian or millet would possibly have served the purpose well.

The soil should be rich and given thorough preparation. Clay soils which are inclined to be lumpy require extra precaution in fitting. The amount of seed required varies from one-half bushel to three pecks per acre, which should be harrowed in lightly and rolled. On freshly cleared or bottom-land soils it makes a rank growth and is available for forage at a time when it is usually found necessary to supplement the pastures. Though it is a gross feeder yet this fact may be of actual benefit to the kinds of soil just mentioned.

Feeding millet green.

When stock is turned in upon a field of green millet for the first time, or a heavy feed is given, there is danger that serious results may follow. Animals not accustomed to green forage should not at first be allowed a full feed of any green crop, especially millet, but should be given only a part ration of the green material. If allowed to gorge themselves serious results may follow. If it is desired that the animals be turned upon the crop to pasture this should be done only after their appetite has been partly appeased by other food.

Millet hay is not in popular favor owing to the fatal results which, in some cases, have followed its use. Just why these unsatisfactory results sometimes follow does not seem to be clear. In feeding it to horses caution should be observed and the millet hay used in conjunction with some other coarse fodder. Much of the value of millet hay seems to depend upon the time of cutting, which should be done soon after blossoming.

SORGHUM, TEOSINTE, SACALINE, ETC.

These crops are mentioned in this bulletin only for the fact that many inquiries are received asking about their merits for this section. While sorghum seems to possess some value, yet for forage, corn is so far superior, when all things are considered, that where it can be raised sorghum is not a necessity in the rotation. It seems to possess its chief value in the fact that it is able to withstand drought and grow under conditions where corn would be a failure. So far as our experiments with teosinte and sacaline go we cannot recommend them for general use. Though they may possess value for certain localities, yet in New York there are so many crops which can be successfully grown for forage that the farmers should be slow to adopt the new varieties except by way of experiment until they have been tested and proven of value.

CRIMSON CLOVER.

Figure 79 shows a plat of crimson clover, the seed for which was sown August 1, the photograph being taken late in October. This clover was growing on land from which a forage crop of oats and peas had been cut. There has been much discussion at Farmers' Institutes and in the columns of the Agricultural press as to the value of crimson clover in this state, as a forage crop and as an improver of the soil. To answer these questions in part and to determine the relative value of the different clovers there were planted side by side on August 1, 1896, three plats of clover, one of crimson, one of common red and one of mammoth. The soil were gravelly and porous. All varieties of clover came up quickly and made good growth. The crimson clover, however, made far more rapid growth in the fall than did the others.

One object of these experiments was to determine the amount

79.—*Plat of Crimson Clover.*

of nitrogen stored up by the different varieties of clover. On November 2, samples were taken of each kind of clover, the roots and tops of each being taken as the sample. The chemical analysis shows the following amount of nitrogen stored up in each per acre.

Variety of clover.	Nitrogen in tops (pounds).	Nitrogen in roots (pounds).	Total pounds of nitrogen per acre.
Crimson............	125.28	30.66	155.94
Red................	63.11	40.25	103.36
Mammoth	67.57	78.39	145.96

All clovers wintered well, but in the spring the freezing and thawing killed nearly all of the crimson clover. It had, however, served its purpose as a cover crop and for late fall pasture would have been valuable, leaving in the ground enough fertilizing material to pay for the expense of the seeding.

SUMMARY.

1. Some provision should be made on every stock farm for forage and soiling crops.

2. The most valuable crop for the production of late forage is corn, and corn planted in hills is more valuable for feeding purposes that when drilled or sown broadcast.

3. Oats and peas are second in value to corn for the production of forage. For late forage barley and peas are recommended.

4. Millets are valuable and when fed properly may be used without danger.

5. Crimson clover proved valuable for late fall pasture and as a cover crop. Its greatest value with us was from the fact of its storing up nitrogen so abundantly.

I. P. ROBERTS.
L. A. CLINTON.

Bulletin 136. May, 1897.

Cornell University Agricultural Experiment Station.

ITHACA, N. Y.

HORTICULTURAL DIVISION.

CHRYSANTHEMUMS

OF 1896.

By L. H. BAILEY and WILHELM MILLER.

PUBLISHED BY THE UNIVERSITY,
ITHACA, N. Y.
1897.

ORGANIZATION.

BOARD OF CONTROL:

THE TRUSTEES OF THE UNIVERSITY.

STATION COUNCIL.

President, Jacob Gould Schurman.

Hon. A. D. White,	Trustee of the University.
Hon. B. F. Tracey,	President State Agricultural Society.
Professor I. P Roberts,	Agriculture.
Professor G. C. Caldwell,	Chemistry.
Professor James Law,	Veterinary Science.
Professor J. H. Comstock,	Entomology.
Professor L. H. Bailey,	Horticulture.
Professor H. H. Wing,	Dairy Husbandry.
Professor G. F. Atkinson,	Botany.

OFFICERS OF THE STATION.

I. P. Roberts,	Director.
E. L. Williams	Treasurer.
Edward A. Butler	Clerk.

ASSISTANTS.

M. V. Slingerland,	Entomology.
G. W. Cavanaugh,	Chemistry.
L. A. Clinton,	Agriculture.

In pursuance of the provisions of Chapter 128 of the Laws of 1897, the following persons have been appointed investigators and instructors in the College of Agriculture of Cornell University to serve throughout the state according to the needs of the several localities for a portion or all of the year.

J. W. Spencer,	M. V. Slingerland,	A. L. Knisley,
G. T. Powell,	B. M. Duggar,	C. E. Hunn,
G. A. Smith,	J. L. Stone,	H. B. Cannon, Chief Clerk.

Office of the Director, 20 Morrill Hall.
The regular bulletins of the Station are sent free to all who request them.

BULLETINS OF 1897.

124. The Pistol-Case-Bearer in western New York.
125. A Disease of Currant Canes.
126. The Currant Stem Girdler and The Raspberry-Cane Maggot.
127. A Second Account of Sweet Peas.
128. A Talk about Dahlias.
129. How to Conduct Field Experiments with Fertilizers.
130. Potato Culture.
131. Notes upon Plums.
132. Notes upon Celery.
133. The Army-Worm in New York.
134. Strawberries under Glass.
135. Forage Crops.
136. Chrysanthemums of 1896.

CORNELL UNIVERSITY, ITHACA, May 10, 1897.

HONORABLE COMMISSIONER OF AGRICULTURE, ALBANY,

Sir:—The following bulletin from the Horticultural Divison is a part of the work which was planned under the Nixon Bill for last year. For two or three years considerable work has been done by this station in floriculture, with the object of helping both florists and flower-lovers everywhere. The bulletins have awakened much interest and have, undoubtedly, done much good in calling attention to a branch of agriculture which has heretofore received little consideration from the public institutions of the country. The work has been done with the greatest care and deliberation, and the bulletin is submitted for publication under Chapter 128 of the laws of 1897.

I. P. ROBERTS, Director.

I. GENERAL REMARKS. (*L. H. Bailey.*)

For three years we have made a special effort to study the problems associated with the florists' chrysanthemums, and this is the third report which we have published upon the work. Our object in this, as in all floricultural study, is to help both the general flower-lover and the professional florist, and we cannot, therefore, devote our attention wholly to amateur methods upon the one hand, nor to the raising of exhibition blooms upon the other.

We stand for the buyer as well as for the seller ; and the question therefore at once arises as to what the real measure of a variety is. Is one bloom, or one vase of blooms, chosen from a score or a hundred or a thousand plants which have received the utmost care and forcing, to be taken as the ideal of the variety? It is the fashion to describe varieties of florists' plants from just such blooms,—from those which draw the prizes in the exhibitions. But since there are few persons who can give this extra care and skill to the growing of a few plants, even if they cared to do so, and since only a part (and often a small part) of any number of plants can be expected to give such results, even under extra treatment, it is easy to see why the novelties are so often a disappointment to the buyer. The fact is, that the highly forced and extra-selected exhibition flower is not always the true measure of what a variety is, but is a measure of what may be done with a few plants. The true type or measure of any variety is the composite character which a whole patch gives, under good care. The flower show is of the greatest value as a popular educator and as a source of information and inspiration to the plant-breeder, but it is not the place in which the general flower-grower should expect to see what a variety actually is. It is often possible to select a few most meritorious exhibition blooms from a range of plants of an inferior variety.

If these points are well taken, then it follows that an experiment station, when reporting upon the merits of varieties, should

aim to present a true composite picture of what the variety is when grown under good and fair conditions. If the station exhibits, its province seems to lie in the same direction. At all events, the writer will never consent to make an exhibit of varieties from the station unless he can show everything, good and bad alike. This is not saying that he disparages the display of exhibition blooms by a station, but in such cases the exhibition is to show cultural methods, not to show varieties. If a station desires to test the varieties of any plant, it exceeds its aim when it endeavors to see how much it can improve those varieties by forceful culture ; for the purpose is to find out what the varieties are, not what they may be compelled to be. And even if the experimenter were to desire to force every variety to the exhibition standard, he could not do so with several hundred varieties ; and to force one and not another would be anything but truthfulness. These remarks seem to be necessary in order to place the subject of variety-testing in its true light, and to let florists see why it is that our descriptions of varieties are sometimes so unlike the descriptions in catalogues.

Another feature of the subject needs also to be touched upon. We said upon a former occasion that we do not always receive the best stock which dealers have. By this we mean that we believe that the ordinary run of commercial stock is commonly received, whilst the exhibition blooms at the flower shows are preferably grown from extra-good stock, which, in many cases, is not for sale. It is no doubt better that an experiment station should receive this commercial stock, for it thereby arrives at a more truthful conclusion as to the actual merits of the variety. In some cases we have received plants which are so poor that no fair and true idea of the variety can be obtained from them ; and from such stock, and from that which may have received inadequate attention on our own part, we intend never to publish results. These remarks are made for the sole purpose of emphasizing the fact that the quality of the stock,—as respects vigor, healthfulness, early propagation, and the like,—is of the utmost importance in the growing of any plant, and particularly of florists' flowers. To bring the subject home, we have inserted a picture (Fig. 82, page 308) showing the variation with which

we often have to contend in the testing of plants. The two plants at the left are fit to produce excellent flowers (though not trained for the production of exhibition blooms) whilst those at the right are plants which are expected to be compared with them. The past season it was so necessary to give forceful culture,—by very heavy fertilizing,—to bring some of the plants into line, that the strong plants (which grew in the same bed) received an additional and perhaps untrue advantage. Even then, some of the plants could not be made to bloom.

It may be well to say, once for all, that these estimates of floral novelties are not mere hurried and incidental measurements and opinions. When any flower is under test, at least one man lives with it when it is in bloom. He spends the greater part of his time with it. Every description of the varieties is read and compared with the plants, the flowers are studied from every point of view, and an opinion is obtained from every visitor who has a critical knowledge of the subject. This careful study day by day is more than the florist, busy with the demands of trade, can expect to give. The errors, therefore, are those which are to be attributed to faulty judgment and to the behavior of plants grown from poor stock. In the following chrysanthemums, for example, the judgments are not those of Mr. Miller alone. They are a compound of the opinions of himself, Mr. Hunn, myself, and of many persons who visited us.

This means that we desire to do more, if we can, than to make a mere variety test. We should like to keep pace with the range of variation, the tendencies, and the needs, in any plant which we study. We have no desire simply to recommend varieties. We have no interest in a variety as such. If, for example, we commend Lenawee amongst chrysanthemums, it is not because we have the slightest concern for that variety as an entity or trade novelty, but simply because that name has been applied to what seems to be the highest development of a particular type of white flower. We hope that the evolution will reach a higher point in the present year.

A leading difficulty with old varieties of any flower is the fact that they tend to run out by variation. The very fact that such various results are got from different grades of stock is proof that

a variety may soon be broken up into a number of strains, some of which may be good and others bad. The careful grower, therefore, will either propagate his own stock of the varieties which he likes or else exercise the greatest care to see that the stock he buys comes from plants which are true to the type.

In respect to the varieties of chrysanthemums, I am convinced that there is too great a tendency to grow novelties. Some of the old varieties are still the best of their class and should be retained, and very many of the novelties—in fact, most of them—seem to represent no distinct advance. It appears to us as if these novelties are not always thoroughly tested and understood before introduction. If we could have a few extra-choice things introduced each year and all the rest left in oblivion, the interests of all parties would be more permanently enhanced.

We need, also, to give greater attention to the hardy or border varieties of chrysanthemums. We have given such exclusive attention to the glass-house flower that the very name chrysanthemum has come to mean, to people at large, the great, noble, florists' flower of November. But there are humbler forms of the plant which may be set in the open ground and there allowed to remain year by year, the same as they did in our mothers' gardens. Some of the modern forms of these plants are pretty and interesting. Even the old-time forms are not to be despised, for if they lack size and quality of bloom, they nevertheless give a wealth of color with very little trouble. The title-page illustrates an old-time, out-door type of chrysanthemum familar to a former generation as garden artemisias. Their chief merit is hardiness; The flowers are produced in great profusion, and they extend the season of pompons a month or more after the first frost has killed the dahlias. It is the race from which the large Chinese chrysanthemums of the greenhouses are said to be derived. We still see them in the old gardens, in various shades of red and yellow, and running into whites of the form of Comet asters. The flowers on the title-page are natural size.

II. CORNELL NOTES OF 1896. (*Wilhelm Miller.*)

Chrysanthemums at home—The principles underlying the cultivation of chrysanthemums are the same as those of other plants. Specific directions are given in bulletins 91 and 112. There are two other points which it is well to know. The choice of varieties is all-important to those who delight in getting the highest results from skill and patience. The form can be chosen

80.—*Oriental Glory.* Natural size.

from the illustrations in some of these bulletins and the description will tell the color. It is well to make a list with several substitutes. The best plan of all, if you attend chrysanthemum shows in the fall, is to note down the names of desirable varieties in case the names are given, as they should be. Another good point to understand is the theory and practice of draining a flower pot. The florist who is unwilling to show a buyer how he can straddle the stem of a plant with two fingers, tap the pot gently and lay bare the whole root system and drainage of his plant, is losing an opportunity to instruct his customer and to hold his future interest. If anything is wrong with a potted plant, look at the roots. Some people are afraid to handle plants. A potted plant has no objection to being turned upside down, and whoever has seen the broken bits of crock and the reason for the hole in the bottom of the pot (not made to be closed) will never again sprinkle the leaves of a plant or the surface of the soil only, when he desires to water it. Nature soaks her plants once in a while and capillarity does the rest. Chrysanthemums are for the common people as well as for the florist. Buy strong plants early (in May or early in June) and if you have no pots, plant them in small soap boxes. Make the soil rich, keep the plants free of insects and away from strong winds, train the plant into four or five strong branches (or more or less, as you desire), and pinch out all the buds, save eight or ten. If you want the largest blooms, grow to a single stem and allow only one flower to a plant. As cold weather approaches, the plants may be moved to the window, where they should bloom to perfection.

Amateurs are frequently disappointed in the growing of the novelties. The system of prizes and certificates is of more use to the professional or exhibition grower than to the amateur who is looking for a list of varieties. No amateur can make a mistake who gets good plants of *Laciniatum*, one of the good old forms. *Lillian B. Bird* is one of the most attractive of the tubular kinds and has always had, at Cornell, the softest and purest of light pinks we know among chrysanthemums, unless it be *Good Gracious* (See Fig. 81). This figure shows a "low center" and a "weak neck" two of the ancestral bogies of florists.

The very droop of this stem seems to me to add to the beauty. Indeed, chrysanthemums in vases are sometimes so stiff-necked that they cannot see anything but the ceiling. The list of good old varieties is large, and any wide-awake florist can give reliable information concerning them.

81.—*Good Gracious*, one of the older types.

Cultural notes of the 1896 test.—In 1895, our novelties were grown to a single stem and allowed to produce only one flower each. This is certainly the best commercial method of obtaining exhibition blooms and large cut flowers for sale in the cities.

For all other purposes there is more satisfaction in having three to six flowers on a plant, as we did the past year.

We have never received so uneven a lot of plants as in 1896. It seems to be hopeless to get a uniform lot of plants representing all the novelties, in the year of their introduction. The last lot of American varieties came last year on the last day of August and the plants that were fit for testing together were not planted out in the bed until August 22, a month late for ideal results. This bed was composed of well rotted clay sod and manure, in the proportion of four to one. A liberal sprinkling of bone meal was worked in, and the bed thoroughly cultivated by hand. On the 26th of September, applications of liquid cow manure were begun. Never was there a more uneven lot of plants than those shown in our photographs of the bed, and never has Mr. Hunn, in his long experience with chrysanthemums, dared to give the bedded plants so much stimulating food. The results far exceeded our expectations, and the November display was a brilliant one, although the novelties themselves were not intrinsically as meritorious with us as in 1895, which was a year of exceptional advances.

The importance of beginning early can hardly be over-estimated. We got the best results from such plants as the largest one shown in Fig. 82. This was the typical home-grown plant from March cuttings. The next largest plant was a fair sample of a lot grown from rooted cuttings received April 22. The four small plants represent fair samples of lots received from different sources in summer. All of them were represented in the trial bed and none gave anything like the satisfaction we got from home-grown plants of varieties introduced the year before. There are two great factors in producing chrysanthemums,—the quality of stock received and the subsequent management. How important the former element is may be seen by contrasting Figs. 83 and 84. Here we have the best results that we were able to produce from poor and good stock. Notice how much fewer and weaker the rays are in the one case, and how completely double is the flower of Fig. 84. Indeed the latter has the over-fed look which one often sees in the exhibition hall. Coarse, heavy rays are are not always a varietal characteristic but usually a mat-

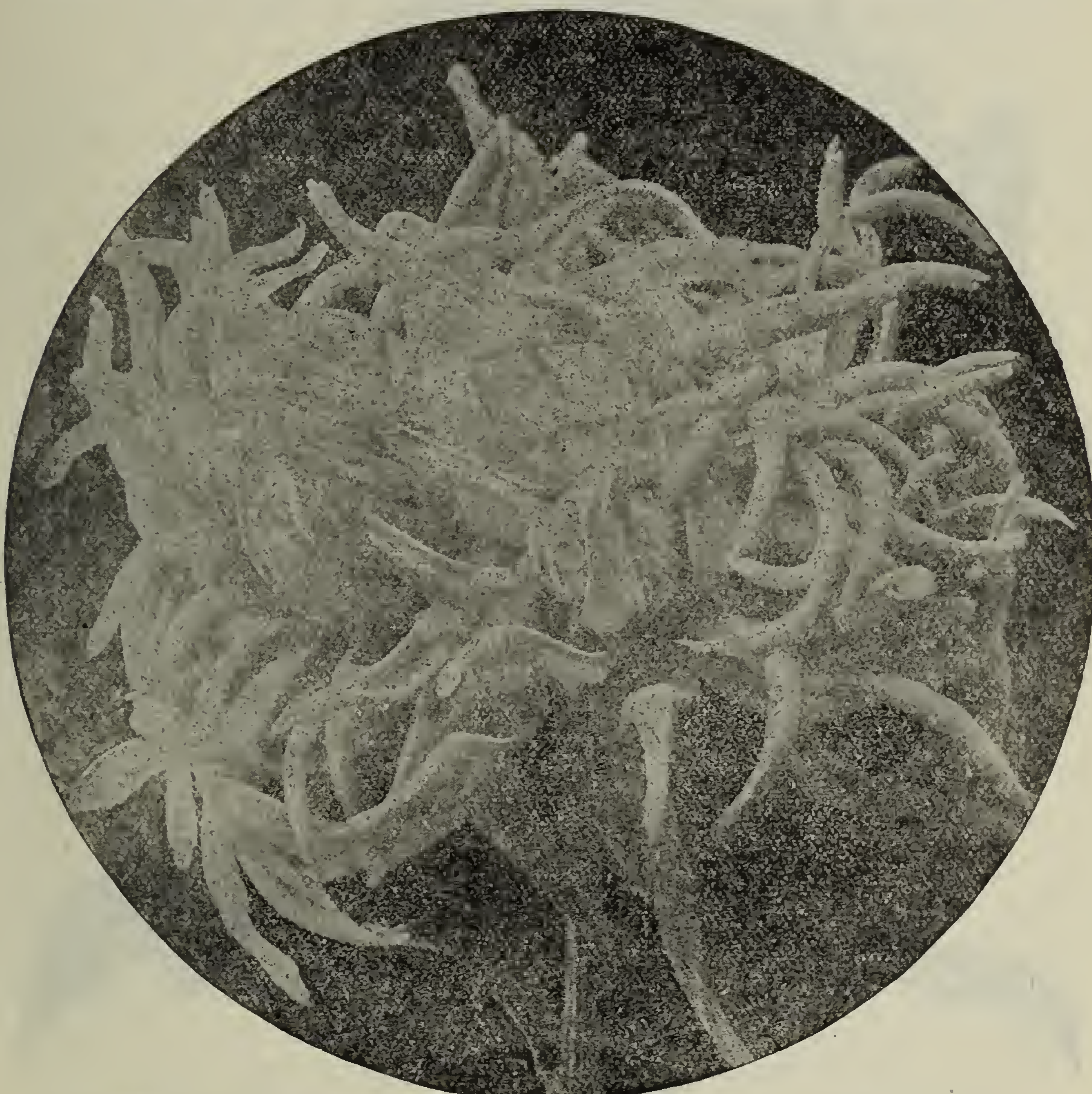
ter of gross feeding, which really obliterates the more refined individuality.

A great year for whites—The year 1895 was marked by great advances among the yellows, and 1896 saw the introduction of many new types of whites. Out of more than one hundred varieties grown at Cornell, five of the six best were whites. These five, *Lenawee*, *Lady Esther Smith*, *Infatuation*, *Yanoma* and *Gretchen Buettner*, are all highly individual and attractive in form. For the third one on this list, *Mrs. W. P. Raynor* would

82.—Photograph Aug. 22. The two larger plants were potted early,—the four small ones received in July.

furnish almost an even choice. We dare not condemn it for being only a few days later, for that may not be a varietal character and no one can know, in a single season, whether it is a matter of culture or variety. Three others are strongly recommended by growers, *Autumn Bride*, *Mrs. H. H. Battles* and *Mrs. R. Crawford*, the first two for earliness, the last for lateness. These three were of familiar types and one of them we have had to condemn for other reasons. The other two we have noticed merely for their seasonable characters, of which no experiment station can judge as well as the large growers can. Three others

we have reluctantly placed on the list of promising sorts, *Miss Helen Wright*, *Dancing Maid* and *White Swan*. We shall try them again and secretly hope that they may be able to hold a place amidst increasingly severer competition. It is hard to pass over *New York* and *Gov. Matthews*, which were first-class in



83.—*Miss Magee*. The best that can be done with poor stock.

every respect but too much like *Mrs. R. W. E. Murray* (recommended in Bulletin 112) to be mentioned except as worthy substitutes. *Gov. Matthews*, it is true, is advertised as a pink, and so were *Mrs. Harry Toler*, *Sibyl Kaye*, and *Rosy Emperatrice*, but they all speedily turned white and were well worth the price as such, the two last, particularly, being an almost even choice

with *Infatuation* and *Lenawee* respectively. *Western King* had a faint primrose tinge but would pass for a white at a distance. *Robert F. Hibson* marks no advance in form, but its productiveness makes it a first-rate commercial white. So far as I know,

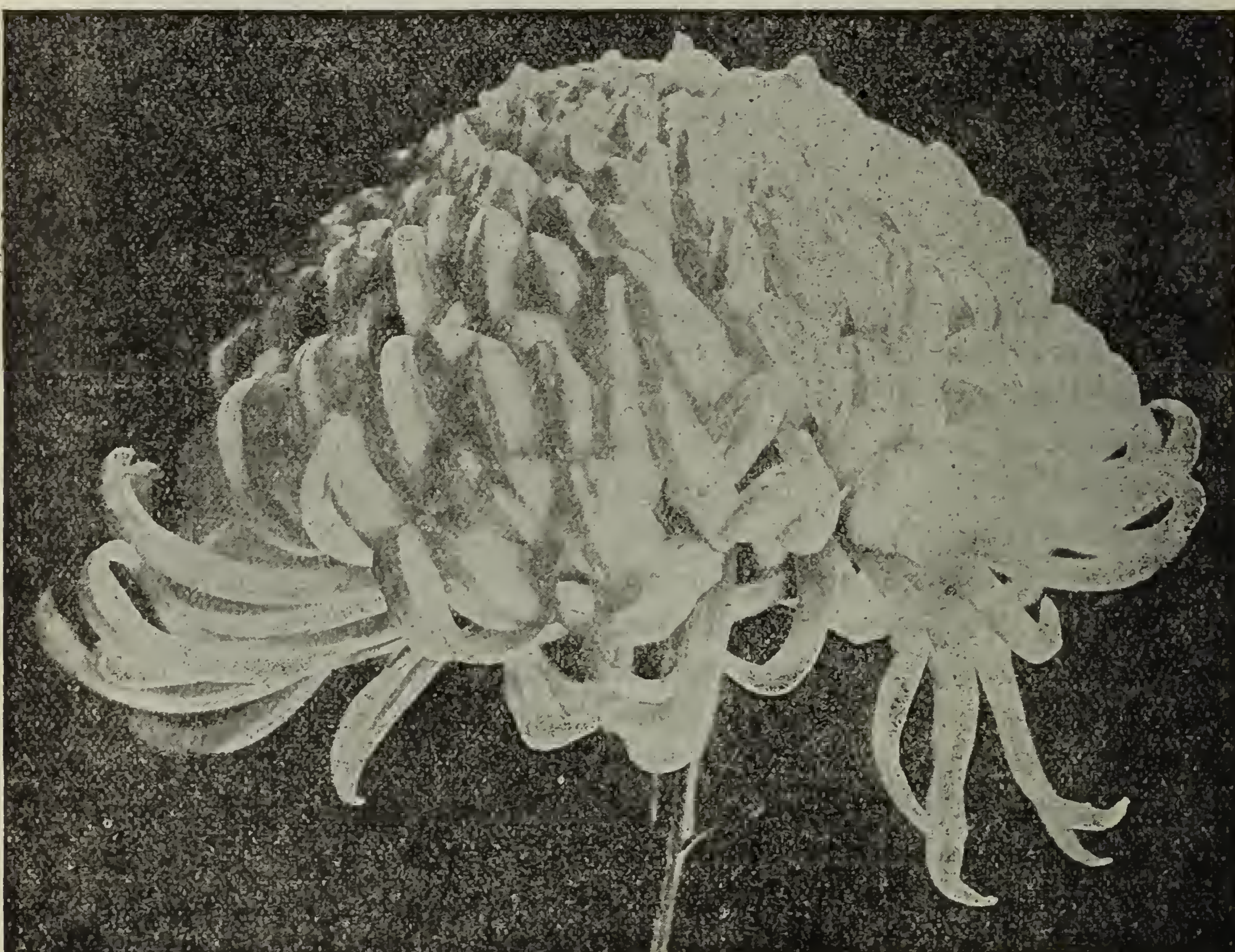
84.—*Miss Magee.* Showing what can be done with good stock. The name is nothing; the quality of the plant is everything.

the ideal hairy white variety is not yet known. *Mrs. Alpheus Hardy*, the first of the type and the one which started the chrysanthemum craze in America, is still extensively grown, but requires experience and skill to bring to perfection. The well-known *L'Enfant de Deux Mondes* is usually weak-necked.

In the yellows, the only advances in form were *Duchess of York* and *Buff Globe*, which latter looks like a buff sport of *Good Gracious* (Fig. 81). *Modesto* had nothing new in form or color but was unusually productive and has the look of a plain, every-day, successful, yellow chrysanthemum.

The pinks were a disappointment this year. Fourteen we have dropped outright. Two varieties (*Sibyl Kaye* and *Rosy Emperatrice*) were first-rate whites but were pink for only a few days. The only successful pink of the year amongst our lot, was *Mme. Felix Perrin* (or *Mrs. Perrin*, for they were as like as two peas), but we feel little confidence in the permanence of the color. We disagree as to the attractiveness of the oft-illustrated *Wm. Simpson*, as men always must differ in matters of liking, but we are agreed that our single plant had a weak stem and poor foliage. Two others, *Mrs. W. C. Egan* and *Miss L. Magee* we have indulgently placed on the promising list because we believe that we had weak stock. The real truth of the matter is that a pure and permanent pink seems not to have been attained. The various shades, from crimson to the faintest crimson-pink, are all treacherous. Even *Viviand Morel*, which is perhaps the best known of all the pinks, old and new, varies in intensity and quantity of color as much as the rest. We do not see how small growers can afford to buy new pinks unless they are sure of the quality of the stock. The number of varieties is very large, and the vigor of the individual plants, according to our experience, is of vastly greater importance ; indeed it often seems to mean all the difference between success and failure. Kind and quantity of plant-food doubtless have something to do with bringing out color, just what we hope to find out this year by experiment on a wide range of shades. Perhaps, too, there are minor and undiscovered causes of this variability, and if there are any uncontrollable factors it is high time that the truth be known. What makes the problem peculiarly puzzling is that *Good Gracious* and a few other varieties have always had at Cornell a uniform amount of delicate light pink with no trace of crimson pink origin. Nevertheless we have never seen any chrysanthemum which matches the pure pink of Schuyler Mathews's color chart.

There seem to be at least four important factors that have to do with intensity of color,—quality of stock, time of rooting cuttings, food supply, and shading. How they are related and which are the most important, it is impossible to say at present. This much is clear, that mere vigor of plants is not all. We never had better plants in any way than *Rosy Emperatrice* and *Sibyl Kaye*, but the color simply showed itself, and was gone.



85.—*Rosy Emperatrice.* Reduced from a ten-inch flower.

Of the various combinations of red and yellow, two are recommended, *Pluto* and *Helen Owen.* Perhaps their forms are not entirely new, but *Pluto* was apparently ideal in all respects within its natural limitations of form and color, and *Helen Owen* was surely the second best of all the English varieties received as regards vigor and productiveness. Six other combinations of these colors were condemned for various reasons and five placed

on the promising list. It seems hard to put *Edwin A. Kimball* on a probation list, for it was perfect of its kind with us last year, but the competition is too keen, the popularity of its type limited, and there is always the possibility of a second year's cultivation reversing one's judgment. So far as we know, it is the best American variety of the type of which *Mrs. C. H. Wheeler* was a famous early representative,—the high-built, almost conical form with heavy, incurved rays, offering frequent suggestions of dark red, while the old-gold of the reverse is the chief feature in the general effect. ("*The Golden Flower, Chrysanthemum*," Mr. Mathews's beautiful art-work has a colored picture of *Mrs. C. H. Wheeler*. That variety appears to be not double enough to suit the florists.) Four English varieties of the same sort have been gathering strength for a fair race with *Edwin A. Kimball* this year, and only one can win.

Two green-flowered plants had little to commend them. They were too exhausted to do much more than declare themselves no monstrosities like the green rose and the green dahlia, but their flowers were weak and yellowish. We shall await their return with curiosity.

Nearly all of the varieties of 1895 recommended in Bulletin 112 were grown again this year, and in general they were not disappointing. *Mrs. Henry Robinson*, the best white of 1895, was not as early in 1896, as expected. *Crimsona* was badly spotted on the face of the rays with the color of the reverse. A rush of work at a critical time caused this collection to be neglected during the disbudding season and we got plants bearing great numbers of small blooms. The mass-effect was very strong, but nearly all of the pronounced types of the year before suffered a loss of individuality. The labor of disbudding chrysanthemums is great and one must always get ahead of the plants.

The variety test of 1896 has been conducted as formerly,

NOTE.—One of the novelties of the year was the Edible chrysanthemum. The plant was the earliest 'mum in the entire collection, but it was of poor habit and bore very few leaves and had a medium-sized yellowish flower of small merit from the florists' standpoint. This variety is said to be cultivated extensively in Japan for the flower heads, which are boiled and eaten ; but we fail to see why this particular variety is more edible than other 'mums.

L. H. B.

photographs, dried specimens, and notes on botanical and horticultural characters being taken. In color determinations, the chart of F. Schuyler Mathews proved as satisfactory as with the dahlias. It answered our purpose well, but the florists and

86.—*Lenawee*. From a white flower eleven inches in diameter.

cataloguers can hardly be expected to use the terminology of the artist. In trying to help the raiser of novelties and the purchasing florist, we shall this time try an experiment. Instead of writing technical descriptions which are apt to be dreary and

mystifying to the general reader and of interest only to the trade, we have given accounts of behavior and judgments of merit. The men who created these things have described them in their own catalogues. Moreover, no description can have the influence of a picture, and in this picture-making age there are few novelties that are not illustrated in the catalogues or trade journals.

While all admit that it is unsafe to recommend or condemn any novelty on one year's acquaintance, some judgment must be made. By placing the word "good" at the head of the following list we do not mean to guarantee the essential and permanent merit of any variety. These varieties are the ones that behaved best with us, and of the hundred or more sorts tested, these twenty are, in our judgment, the ones most likely to achieve anything resembling permanent success. But the problems of variety-study must forever contain uncontrollable factors. The analysis can never be complete, and therefore the prophecy can never be as certain as in some other departments of science.

GOOD VARIETIES.

Twenty-four varieties are named somewhat in the order of merit under their respective colors. The names in parentheses indicate the source of stock plants and usually the introducer.

Whites.

Lenawee (Smith).—By far the largest and most attractive flower in our collection of 1896. The form is strikingly individual. Early, prolific and one of the longest keepers. The only possible objection to it is that it may be too flat and sprawling for use in bunches of cut flowers. Fig. 86.

Smith, Lady Esther (Owen).—Easily the largest and best of the varieties received from England for trial. Rays four inches long and often an inch or more wide, very flat, and of good substance. Apparently quite ideal.

Infatuation (May).—Smaller than the last but of good size. Early, and lasts three weeks on the plant. Form distinct and attractive. *Mrs. W. P. Raynor* was a few days later with us, but otherwise almost an even choice with *Infatuation*.

Yanoma (Smith).—By far the best late white we have ever grown. Exceptionally prolific, and has all the traits of thoroughbred commercial sorts.

Buettner, Gretchen (Hill).—A high-built flower of strong enough character to be worthy of a permanent place in the much overcrowded midseason section.

Hibson, Robert F. (P. & M).—Advertised as an early, reflexed Japanese. was midseason with us, prolific, and a good commercial variety.

Raynor, Mrs. W. P. (Spaulding).—A few days later than *Infatuation* but otherwise an almost even choice.

Autumn Bride (Smith).—Mentioned only because of its being the earliest white with us this season. Flowers do not last long.

Crawford, Mrs. R. (Spaulding).—Noticed because it is a late white. Of its lateness and commercial qualities no experiment station can judge as well as growers. *Yanoma* was more prolific and the form more attractive.

Pinks.

Perrin, Mme. Felix (Smith).—Best crimson pink in the bed. The form is regular, incurved, and somewhat stiff. Color faded slightly. Recommended only as being the best pink of the year and not for any permanent advance.

Perrin, Mrs. (Hill).—Color and form were not distinguishable from the above. A few days later was the only difference with us.

Simpson, Wm. (Blanc). The form of this crimson pink variety is more unusual and less conventional than of the preceding. Our single plant had a large, early, long-keeping flower which faded little, but the foliage was so scattered and the neck so weak as to make it impossible for us to recommend it from our experience for extensive commercial use.

Rosy Emperatriee (Yoshiike).—Pink for only a few days, rapidly fading to white. Almost as large and long-keeping as *Lenawee* and of similar form. Fig. 85.

Kaye, Sibyl (Spaulding).—Faded from pink to white as rapidly as the last, and kept for a long period. The form is somewhat similar to that of *Infatuation*.

Yellows.

York, Duchess of (Hill).—Form reflexed, loose, graceful and flowing. Color a soft and rather light yellow, beside which the next is bold and metallic. It is on three of our four lists of recommended varieties, for it is one of the best yellows we have ever seen.

Modesto (Smith)—Form common but popular. Color bold and strong. It has all the marks of a successful commercial variety.

Other Colors.

Pluto (May).—Red, reverse yellow. The best of its color and type yet seen at Cornell. While essentially a commercial sort, it is just the thing for amateurs because of its interesting stages of development.

Buff Globe (Yoshiike).—Noted as having the peculiar form and drooping habit of *Good Gracious* which is very attractive to many people. The color is pretty and restful but cannot compete for attention in a large crowd with the more vivid ones.

Owen, Helen (Owen).—A deep, quickly incurving Japanese flower, with a low center like that of *Good Gracious*, the youngest rays tightly whorled and showing the sulfur reverse. Face of rays chiefly brownish flesh and yellow. There is plenty of room for this and *Pluto*.

Violescent (Smith).—A large, deep, compact flower, the pinkish tinge being delicate and rather short-lived with us. An ideal commercial and exhibition sort, if one could be sure of the color. Even as a white variety, however, it would be a distinct success.

Oriental Glory (Yoshiike).—High built, compact, cylindrical, whorled, white, the whorled inner rays suffused with delicate crimson pink which fades as flower becomes older. The cylindrical form relaxes about the same time to the spherical. We had only one plant and one flower and cannot judge of its commercial qualities. Fig. 80.

Western Pride (Yoshiike).—Cardinal, reverse greenish yellow. Recommend to amateurs who like fantastic and Japanesque creations. The younger stages are the most eccentric and interesting.

Hairy.

Midnight (Spaulding).—Noted because it is an odd color in this class. The shade of crimson is rather dull and not as attractive as the familiar *Louis Boehmer*. *Mrs. H. N. Higinbotham* has been grown here to a much greater size.

Freeman, Mrs. C. B. (Spaulding).—This is the only yellow variety we have seen of this class. The color fades as much as the very popular *Philadelphia*.

From the preceding twenty-four varieties we have made selections for special purposes:

General collection of ten for commercial purposes: *Lenawee*, *Lady Esther Smith*, *Infatuation*, *Mme. Perrin*, *Pluto*, *Modesto*, *Duchess of York*, *Yanoma*, *Violescent*, *Gretchen Buettner*.

Six varieties for exhibition: *Lenawee*, *Lady Esther Smith*, *Mme. Perrin*, *Pluto*, *Modesto*. To complete the set Mr. Hunn and Mr. Hasselbring (a practical florist) would choose *Violescent;* Mr. Miller would choose *Oriental Glory*.

Six varieties for pot plants: *Lenawee*, *Mme. Perrin*, *Pluto*, *Modesto*, *Duchess of York*, *Yanoma*.

Amateur's list of six: *Oriental Glory*, *Duchess of York*, *Mrs. C. B. Freeman*, *Buff Globe*, *Gretchen Buettner*. To complete the set Mr. Hunn and Mr. Hasselbring would choose *Helen Owen;* Mr. Miller would choose *Western Pride*.

PROMISING VARIETIES.

The following list contains varieties of all degrees of merit, and especially those which by reason of lateness of arrival (e. g. the English), or poor quality of stock, did not have fair play this season. The figures at the left are the numbers of the varieties on our own books.

8. *Alps.*
1. *Ashmead, F.*
4. *Avellan, Amiral.*
10. *Bonnie Dundee.*
12. *Buettner, Emil.*
28. *Dancing Maid.*
29. *Devis, W. S.*
30. *Egan, Mrs. W. C.*
33. *Emerald Gem.*
36. *Godfrey, Mrs. J. W.*

38. *Green Emerald.*
45. *Invincible.*
48. *Ito, Admiral.*
54. *Kahma.*
50. *Kimball, Edwin A.*
61. *Magee, Miss L.*
60. *McHattie, J. W.*
72. *Owen, Walter.*
82. *Ridgeway, Lady.*
81. *Roberts, Gen.*
94. *Taiwan.*
87. *Triomphe de St. Laurent.*
99. *Western King.*
98. *Wright, Miss Helen.*

UNPOPULAR VARIETIES (*the Chinese type.*)

The varieties 20 and 88 here named were the best of the novelties in this now unpopular class. These varieties are good of their type, but the Chinese or ball-form class is in such little favor that it seems almost necessary to put these varieties in the unpromising list. All the rest of our Chinese sorts of the year were much below the average of what we have formerly seen.

13. *Bock, Betty.*
21. *Columbine.*
20. *Curtis, Chas. H.*
44. *Haigh, George.*
42. *Hatfield, Mrs. T. D.*
51. *Kingston, Mrs. R. C.*
62. *Mongolian Prince.*
88. *Signal Light.*

LESS PROMISING VARIETIES.

The following list of less promising varieties contains those novelties in which we seem to detect essentials that are likely to disqualify them permanently; the judgments are formed solely upon the behavior of the plants at Cornell in 1896. How to treat the great number of sorts that are no improvement on old and established kinds but apparently just as good, is a perennial puzzle. (I am not speaking of those that are identical, but of those that are so similar as to be horticulturally synonymous.) Our rule is to offer them as equivalents or substitutes whenever their merits are urgent, and discard the rest. Fine flowers do not make fine varieties. We know how the old plants respond to cultural conditions, but what of the new?

Varieties and fashions are proverbially ephemeral and our judgments can hardly be as ruthless as those of Time himself—the Prince of novelty testers. Probably not ten of these hundred new things will be alive in another decade.

The amateur, who loves everything that grows, feels no failures. To the florist, disappointment means dollars. What does the lover of plants care for shipping qualities or the lastingness of cut flowers? The enthusiast's standards do not know the oxidizing touch of trade.

To the introducer and to the florist, we merely report that the varieties named below seemed failures to us for reasons that we will gladly communicate privately, just as we are glad to furnish an account of the behavior of any collection of numbered seedlings, which may be sent us. No variety has been dropped for any one reason, and particularly not for misbehavior during one season, for such failure is sometimes a matter of variety and sometimes a matter of individual plants. We give in brief compass some hints as to the most obvious defects in the varieties named below. To avoid multiplication of words, numbers are used instead of names:

Lacking size 16, 19, 91; poor habit 32, 39, 58, 68; lacking productiveness 18; too much center 6, 39; raggedness 7; coarse and heavy 11; seasonal (not early or late as advertised) 16, 91, 35, 65; crimson pink (color unstable, or badly laid on) 3, 5, 6, 7, 11, 19, 24, 35, 37, 57, 65, 75, 85; foreign to Amerall the Chinese; dark colors unpopular for cut flowers 43, 55, 58; red-andican taste 49, and yellows more popular in England than here 22, 67, 70, 83; no improvement over old sorts known to us 22, 39, 41, 43, 52, 59, 65, 68, 70, 73, 77, 78, 83, 91, 100.

7. *Alonzo.*
3. *Amaranth.*
5. *d'Angleterre, Reine.*
6. *Antoinette.*
16. *Battles, Mrs. H. H.*
11. *Biddencope, J.*
18. *Budd, Gov.*
22. *Clarence.*
19. *Consuelo.*
24. *Dalskov, Miss Agnes E.*
32. *Edible.*
35. *Glory of the Pacific.*
39. *Golden Harvest.*
37. *Great Port.*
43. *Headlight.*
41. *Hurrell, Henry.*
49. *Jones, M. H. J.*
52. *Keim, J. R.*
55. *Lear, Miss M.*
59. *Liberty.*
58. *Loomis, Adelaide.*
57. *Louise.*
67. *Mars.*

65. *Matthews, Gov.*
68. *Miller, Paul L.*
69. *Nanshon.*
70. *New York.*
73. *Oyama, Marshall.*
78. *Peabody, Mrs. J.*
75. *Pratt, Cecil.*
85. *Rena Dula.*
83. *Rinaldo.*
90. *Snow Field.*
77. *Souvenir de Petite Amie.*
91. *Terrell, Constance.*
93. *Tippecanoe.*
97. *Violet King.*
100. *Whitcombe, Jessie.*
101. *White Swan.*

NOT TRUE TO NAME.

9. *Bellem.*—Not true to description. Advertised pink. Was primrose-yellow

14. *Buettner, Mrs. Emil.*—Not true.

31. *Ellis, Ruth.*—Not true. Advertised as blush white. Was a faint yellow fading much more than *Philadelphia.*

92. *Toler, Mrs. Harry.*—Advertised as flesh pink, slightly hairy, full and double. With us, this was a good commercial midseason white but *Robert F. Hibson* was more completely double.

103. *Yellow Plume.*—Was pink with us.

SUMMARY.

A few plants can be grown in the home window and made to produce flowers equal to any pictured in this bulletin. Page 305.

Take note of varieties at your local flower shows and insist on the educational side of the exhibit.

Amateurs will take most comfort in growing plants having three to six large characteristic flowers. Page 307.

The quality of stock plants is of the highest practical importance. Page 307.

The great advances in form among the introductions of 1896 were made in the whites. Page 308.

Modesto, the most productive yellow of the year, is typical of commercial standards. Page 311.

No true pure pink appears to have been obtained in chrysanthemums.

The intensity of color among the so-called pinks depends upon little-understood cultural conditions. Page 313.

Lists of varieties recommended on the basis of one year's behavior on Page 317.

List of varieties that failed to give satisfaction at Ithaca in 1896 on Page 320.

L. H. BAILEY.
WILHELM MILLER.

Bulletin 137. May, 1897.

Cornell University Agricultural Experiment Station,

ITHACA, N. Y.

Agricultural Extension Work:

SKETCH

of its

Origin and Progress.

PUBLISHED BY THE UNIVERSITY

ITHACA, N. Y.

1897

ORGANIZATION.

BOARD OF CONTROL:

THE TRUSTEES OF THE UNIVERSITY.

STATION COUNCIL.

President, JACOB GOULD SCHURMAN.

Hon. A. D. WHITE,	Trustee of the University.
Hon. B. F. TRACY,	President State Agricultural Society.
Professor I. P. ROBERTS,	Agriculture.
Professor G. C. CALDWELL,	Chemistry.
Professor JAMES LAW,	Veterinary Science.
Professor J. H. COMSTOCK,	Entomology.
Professor L. H. BAILEY,	Horticulture.
Professor H. H. WING,	Dairy Husbandry.
Professor G. F. ATKINSON,	Botany.
M. V. SLINGERLAND,	Assistant in Entomology.
G. W. CAVANAUGH,	Assistant in Chemistry.
L. A. CLINTON,	Assistant in Agriculture.

OFFICERS OF THE STATION.

I. P. ROBERTS,	Director.
E. L. WILLIAMS,	Treasurer.
EDWARD A. BUTLER,	Clerk.

In pursuance of the provisions of Chapter 128 of the Laws of 1897, the following persons have been appointed investigators and instructors in the College of Agriculture of Cornell University to serve throughout the state according to the needs of the several localities for a portion or all of the year.

J. W. SPENCER,	M. V. SLINGERLAND,	A. L. KNISLEY,
G. T. POWELL,	B. M. DUGGAR,	C. E. HUNN,
G. A. SMITH,	J. L. STONE,	H. B. CANNON, Chief Clerk.

Office of the Director, 20 Morrill Hall.
The regular bulletins of the Station are sent free to all who request them.

BULLETINS OF 1897.

124. The Pistol-Case-Bearer in western New York.
125. A Disease of Currant Canes.
126. The Currant-Stem Girdler and The Raspberry-Cane Maggot.
127. A Second Account of Sweet Peas.
128. A Talk about Dahlias.
129. How to Conduct Field Experiments with Fertilizers.
130. Potato Culture.
131. Notes upon Plums.
132. Notes Upon Celery.
133. The Army-worm in New York.
134. Strawberries under Glass.
135. Forage Crops.
136. Chrysanthemums.
137. Agricultural Extension Work, sketch of its Origin and Progress.

AGRICULTURAL EXTENSION WORK: SKETCH OF ITS ORIGIN AND PROGRESS.

The law under which the extension teaching of agriculture is now being prosecuted in New York State by the College of Agriculture of Cornell University, at first was an Experiment Station measure. The bill originated entirely with the people, when, in 1893, certain Chautauqua County persons asked the Station to undertake experiment work in their vineyards. We replied that while we should like to take up the investigations, our funds were insufficient to meet the expense without endangering work in which we were already engaged; and this lack of funds would be keenly felt if other sections of the state should also, following the Chautauqua example, ask for help. We suggested to them, therefore, that if their local horticultural society could raise sufficient funds to meet the expense of fertilizers, traveling and incidentals, we would try to detail a man to look after the work. The matter dropped there; but the next winter we heard of a movement among the Chautauqua people to obtain a small state appropriation to pay for experiment work in their vineyards. The project was placed in the hands of S. F. Nixon, Assemblyman from Chautauqua County, who, early in 1894, obtained a grant of $16,000, one-half of which was to be expended by the Cornell Experiment Station in work in horticulture in the Fifth Judicial Department of the State, an area comprising sixteen counties of western New York. This is the only instance, so far as we know, of a movement for experiment station work which has been initiated and pushed to a final passage wholly by a farming community. The laws upon which our land-grant colleges and the agricultural experiment stations are founded were conceived and completed almost wholly by a comparatively small body of educators and experimenters, aided by persons in the various professions.

The clause in the law of 1894 which appropriated money to

the Cornell University Experiment Station, is as follows: "The sum of eight thousand dollars, or so much thereof as may be necessary, is hereby appropriated, to be paid to the agricultural experiment station at Cornell University, for the purpose of horticultural experiments, investigations, instruction and information in the fifth judicial department, pursuant to section eighty-seven of the agricultural law." The law also provides that "such experiment station may, with the consent and approval of the commissioner of agriculture, appoint horticultural experts to assist such experiment station, in the fifth judicial department, in conducting investigations and experiments in horticulture; in discovering and remedying the disease of plants, vines and fruit-trees; in ascertaining the best means of fertilizing vineyards, fruit and garden plantations, and of making orchards, vineyards and gardens prolific; in disseminating horticultural knowledge by means of lectures or otherwise, and in preparing and printing, for free distribution, the results of such investigations and experiments, and such other information as may be deemed desirable and profitable in promoting the horticultural interests of the state. * * * * All of such work by such experiment station and by such experts shall be under the general supervision and direction of the commissioner of agriculture." This bill became a law, by the Governor's signature, May 12, 1894. In the legislature of 1895, Mr. Nixon introduced a bill to continue the work, but increasing the amount given to Cornell University Experiment Station to $16,000. This second bill became a law on the 4th of April, 1895.

Upon taking up the work provided for by the bill, in the early summer of 1894, the Cornell University Experiment Station placed the enterprise in the hands of a chief "horticultural expert," in the language of the law, and Professor L. H. Bailey was chosen to that office, with the expectation that most or all of the work should be completed during the summer interrim. In entering upon his duties, this officer laid out three general lines of work, as specified in the law,—"conducting investigations and experiments," "disseminating horticultural knowledge by means of lectures or otherwise," and "preparing and printing" the results of the work. In other words, the work was to be divided between research, teaching, and publication.

The enterprise was new and untried; the territory to be covered was large, the interests varied, and the demands numerous; and the promoters of the bill had large expectations of the results. The responsibility of inaugurating the enterprise was keenly felt, or a mistake in the beginning might be expected to exert a serious and baneful influence upon future legislation designed to improve the conditions of rural life. The officer in charge was extremely fortunate, however, in having the hearty support of his colleagues, the free coöperation of the commissioner of agriculture, and, above all, the kindly and intelligent interest of scores of horticulturists in his territory. It was conceived that, in the beginning, a comparatively small and well digested enterprise prosecuted by a few carefully chosen men would be productive of better results than any bold attempt, with a large force, to carry the work into every part of the fifth judicial department. Inasmuch as the original grant was obtained through the exertions of the grape-growers of Chautauqua County, it was designed to undertake careful studies of the vineyard interests at the outset. The immediate charge of this work was placed in the hands of the late E. G. Lodeman, assistant in horticulture, who, to fit himself more specifically for certain problems which were presenting themselves, went to Europe (at his own expense) and visited the vineyards of the Rhine, of Italy and Southern France. The entomological inquiries were placed in the hands of M. V. Slingerland, assistant entomologist of the Experiment Station. Certain lines of investigation made at Ithaca were placed in immediate charge of Michael Barker, who was secured from the Botanic Gardens of Harvard University. We also associated with us for a time in certain field work, Harold G. Powell, a senior in agriculture in Cordell University, and one who had had much experience in pomological matters.

In 1895 the work was placed under the supervision of Professor I. P. Roberts, the director of the station (who was absent the previous year) and Professor Bailey, but immediate charge of it was given, as the year before, to the latter officer. Some additional help was secured because of the larger work which was demanded by the larger appropriation; but in general the enterprise went forward upon the same lines as in 1894.

A third appropriation was made by the legislature of 1896 of $16,000; but since the new state constitution had abolished the Fifth Judicial Department, the fund was applied to the Fourth Judicial Department comprising twenty-two counties bounded eastward by Jefferson, Lewis, Herkimer, Oneida, Onondaga, Cayuga, Tompkins, Seneca, Yates and Steuben.

The legislature of 1897 made a fourth appropriation, but now it applies to the entire state and to agriculture in general. Moreover, it is given to the College of Agriculture (not to the Experiment Station) for " the promotion of agricultural knowledge in the State." For this purpose $25,000 was appropriated. The attachment of this fund to the general College of Agriculture signalizes the outgrowth of the work from mere experiment (as chiefly contemplated at first) into the general promulgation of agricultural knowledge. With this new bill, the prosecution of the work passed from the hands of Professor Bailey into those of Professor Roberts, the Director of the College of Agriculture.

From the first, the work has been thrown into three general lines,—direct research in the orchards, vineyards and gardens of western New York ; teaching by means of itinerant schools and lectures; and the publication of horticultural knowledge in bulletin form. A somewhat full account of the enterprise up to nearly the time when it passed wholly from Professor Bailey's hands may be found in Bulletins 110 and 122. From the funds of the first three years—when the work was restricted to horticulture—49 bulletins have been published, and investigations for several others have been completed. These bulletins have been of five general types : 1. Those which attempt to improve the cultivation of the staple crops ; 2. Those which endeavor to expound well known principles and facts ; 3. Those which aim to awaken an interest in flowers and nature and the amenities of rural life ; 4. Those which suggest new avenues of profit ; 5. Those which attempt to monograph certain difficulties (as given insects and fungi) with which the horticulturist has to contend. In all of them, it has been the desire to make the matter attractive and readable, so that the entire bulletin would be prized and kept by the recipient.

The animus of the entire enterprise has been an attempt to

inquire into the agricultural status, to discover the causes of the rural depression, and to suggest means for improving the farmer's position. This attempt has been specifically directed to a single great branch of rural industry, horticulture, in pursuance of the provisions of the law; but what is true of the horticultural communities is essentially true of other agricultural regions, and, morever, these two types of agricultural industry cannot be separated by arbitrary lines. The work, therefore, has practically resulted in a broad study of rural economics. We conceive that it is impossible to really extend the Experiment Station and University impulse to the people in such manner that it shall come to them as a living and quickening force, without first studying the fundamental difficulties of the farmers' social and political environment.

In this extension work, therefore, we have sought not so much for new facts as for some way of driving home the old facts. We have tried to set forces at work which would silently extend themselves when we had left them. Fortunately, we have been greatly aided by the hard times and the multitudes of bugs and special difficulties. These things have driven people to thinking and to asking for information. The agricultural communities are thoroughly aroused, and now is the time to teach. When one is thoroughly prosperous in his business, there is little chance—as, in fact, there is generally little need—of teaching him other methods.

The efforts to reach the people, in the progress of our work, may be classified under five general heads. These efforts have all been experiments in methods of extension teaching as applied to horticulture. We have tried to ascertain the value of:

(1.) The itinerant or local experiment as a means of teaching.
(2.) The readable expository bulletin.
(3.) The itinerant horticultural school.
(4.) Elementary instruction in the rural schools.
(5.) Instruction by means of correspondence and reading courses.

In the local experimental work, something over one hundred different experiments have been planned and prosecuted in differ-

ent parts of western New York. These comprise experiments in tilling the land, in pruning trees, in fertilizing the soil, spraying, combating insects and fungi, and the like. The fundamental purpose in these experiments is to teach by means of object lessons and not to collect scientific facts, although the latter often come as a very valuable incidental result.

The bulletins which have been issued under the auspices of the work are public and therefore need no explanation at the present time.

The horticultural schools have been about forty in number. These are meetings which last two or more days, at which time certain instructors take up definite lines of instruction, giving by far the greater part of their attention to underlying principles and not to mere facts or methods. A somewhat full report of these horticultural schools, with the topics and instructors assigned to each, is published in Bulletin 122.

The fundamental difficulty with our agricultural condition is that there is no attempt to instruct the children in matters which will awaken an interest in country life. We have therefore conceived that the place in which to begin to correct the agricultural status is with the children and the rural schools. For the purpose of determining just how much could be expected from this source, many rural and village schools were visited during the past year, the instructors talking to the children about any object which presented itself at the time. The result was that all the instructors were impressed with the readiness with which the children imbibed the information, their keen desire for it and appreciation of it, and the almost universal interest which teachers took in this kind of work. We are now convinced that the greatest good which can be rendered to the agricultural communities is to awaken an interest in nature-study on the part of teachers and children. In order to facilitate teaching in this direction, we have issued five leaflets to show teachers how nature-study may be presented to the pupils, and these have been received with the greatest enthusiasm by educators and others amongst our constituency. The hint for this work in the public schools was derived from the work which was done by George T. Powell, in Westchester County,

under the auspices of the New York Committee for the Promotion of Agriculture. This resulted in a virtual union of the forces in the two parts of the State, and when the people asked the Legislature again during the last winter for an appropriation, the Committee for the Promotion of Agriculture lent its influence in behalf of the bill.

The outgrowth of this work with the schools is that we now consider that the best way in which to reach the pupils and the teachers is by short and sharp observations upon plants, insects and other natural objects, and not by means of definite lectures of stated lengths. This work has already been presented to the teachers at some of their institutes, where it has also met with favor and it has received the commendation of the Superintendent of Public Instruction and other persons in authority. *It will, of course, be futile to attempt to instruct the children of the State in nature-study by means of instructors from Cornell University. We therefore conceive that the real work to be done is to instruct the teachers in the methods of imparting this instruction.* It was with this thought that we began a series of teachers' leaflets and we purpose to present the work at the teachers' institutes and eventually, perhaps, in the Normal Schools and training classes of the State. So far as the present outlook is concerned, it is perhaps not too much to say that we believe that this movement, directed towards the young people of the rural communities, is the most important one which has developed in agriculture since the consumation of the experiment station idea.

Instruction by means of correspondence has been an outgrowth of the last year and has not yet been carried to sufficient maturity to enable us to judge of its full merit and promise. However, there were about 1,600 readers upon our lists at the close of the first three months, and there is no doubt but that a vigorous agitation of the question during another winter will at least quadruple our present list. It is the plan in this reading course to set the farmers to reading upon certain definite subjects which are assigned to them, and then to make them think upon those subjects by periodical questioning. At the present time the texts which have been used are our Bulletin 119 upon the Texture of the Soil, and Bulletin 120 upon the

Moisture of the Soil. These are two fundamental subjects upon which every farmer needs more light. After having read one of these bulletins, a printed circular is sent to each reader asking certain definite questions, which it is desired that he shall figure out, think about and answer for himself. In this way the readers are kept in constant touch with the College of Agriculture, and they are made to think, whether they desire to do so or not.

Aside from the many horticultural investigations which are still continuing from Professor Bailey's work, there are now more than 200 experiments with fertilizers on various kinds of crops in progress throughout the State among the farming community. Five hundred experiments in beet culture, with and without fertilizers, are also being conducted to learn, if possible, the localities in the state best adapted to sugar beet culture and to induce the farmers to investigate this new industry. Instruction is given as to soil, methods of tillage and fertilization. At the same time, numerous experiments are being conducted at the university along lines similar to those mentioned. The College of Agriculture has enrolled under the head of University Extension work fifteen thousand pupils and ten thousand teachers of the public schools, and one thousand six hundred young farmers. The pupils and farmers receive guidance by means of printed circulars and the farmers report progress and difficulties upon special blanks which are furnished. Six instructors are employed throughout the state in conducting University Extension work, and special teachers are employed from time to time as occasion requires. These instructors meet the teachers of the public schools in the presence of their pupils and at teachers' associations and institutes for the purpose of illustrating methods for teaching Nature Studies directly or indirectly related to Agriculture. The leaflets furnished serve as text for the subjects taught.

The result of this pushing of the education motive into the rural communities has been a most decided waking up of the rural communities which, even if the work were to stop at the present time, would continue to exert an influence for a generation and more.

All this work has been experimental,—an attempt to discover

the best method of teaching the people in agriculture. We believe that the most efficient means of elevating the ideals and practice of the rural communities are as follows, in approximately the order of fundamental importance: (1) The establishment of nature-study or object-lesson study, combined with field-walks and in incidental instruction in the principles of farm-practice, in the rural schools; (2) the establishment of correspondence-instruction in connection with reading-courses, binding together the University, the rural schools, and all rural literary or social societies; (3) itinerant or local experiment and investigation, made chiefly as object-lessons to farmers and not for the purpose, primarily, of discovering scientific facts; (4) the publication of reading bulletins which shall inspire a quickened appreciation of rural life, and which may be used as texts in rural societies and in the reading courses, and which shall prepare the way for the reading of the more extended literature in books; (5) the sending out of special agents as lecturers or teachers, or as investigators of special local difficulties, or as itinerant instructors in the normal schools and before the training classes of the teachers' institutes; (6) the itinerant agricultural school, somewhat after the plan of our horticultural schools, which shall be equipped with the very best teachers and which shall be given as rewards to the most intelligent and energetic communities.

In conclusion, it must be said that the farmers, as a whole, are willing and anxious for education. They are difficult to reach because they have not been well taught, not because they are unwilling to learn. It is astonishing, as one thinks of it, how scant and poor has been the teaching which has even a remote relation to the tilling of the soil; and many of our rural books seem not to have been born of any real sympathy with the farmer or any proper appreciation of his environments. Just as soon as our educational methods are adapted to the farmer's needs, and are born of a love of farm life and are inspired with patriotism, will the rural districts begin to rise in irresistible power.

CIRCULAR CONCERNING

Co-Operative Tillage Experiments.

No. 5.

Cornell University,
College of Agriculture.

Ithaca, N. Y., April 15, 1897.

It is desired by the Cornell University College of Agriculture to co-operate with farmers throughout the State in tillage experiments with potatoes and sugar beets. Such marked results have been obtained by the Experiment Station at Cornell University in the tillage of potatoes that it is considered worth while to see if equally marked results cannot be secured by the farmers generally throughout the State. The awakening interest in the home manufacture of sugar and the organization in this State of one or more companies for its manufacture from beets, demand that attention be given to the subject of the culture of sugar beets, and the fertilizers, soil and varieties best suited to their production in different sections of the State.

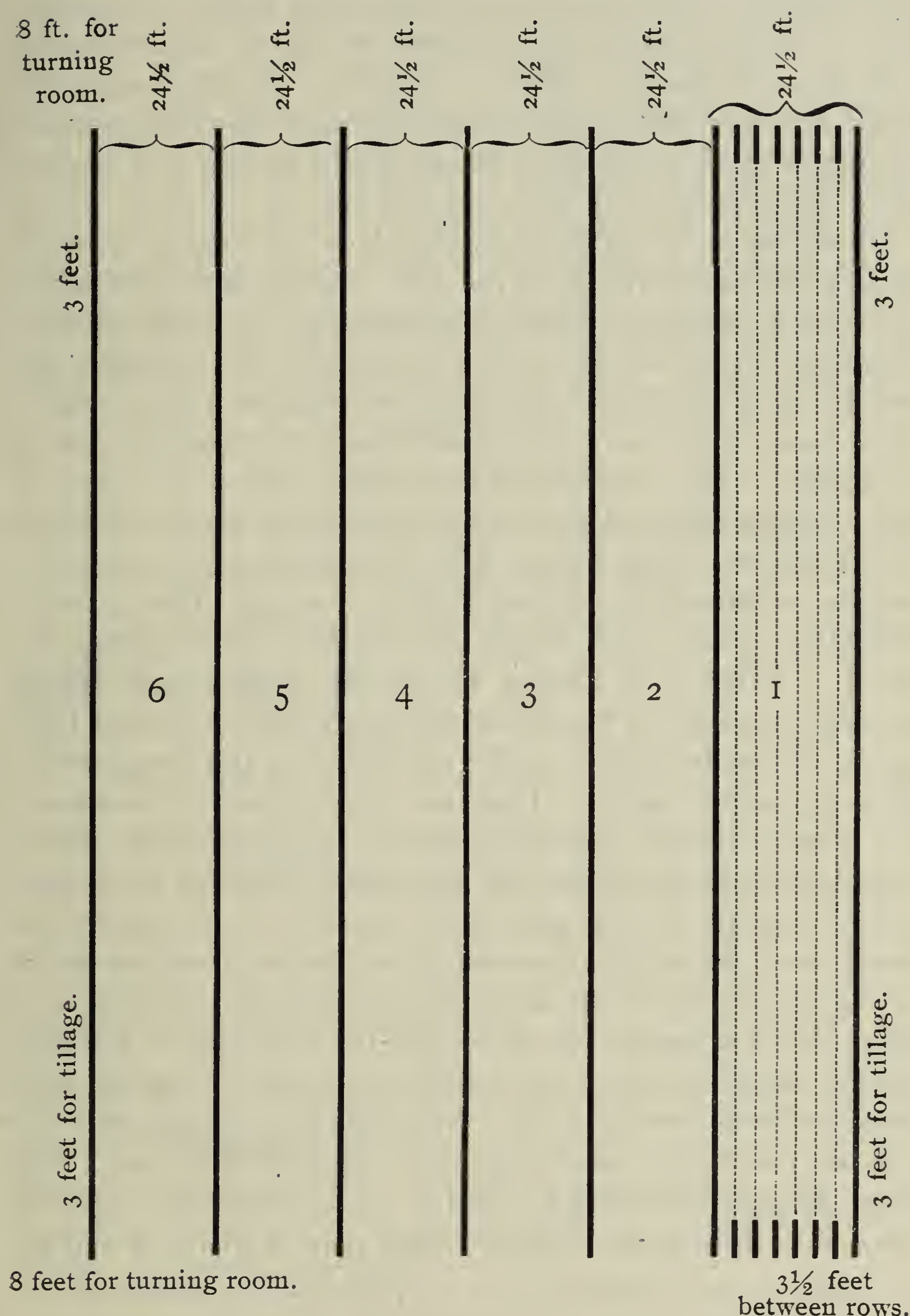
To assist in carrying out this work we invite the co-operation of all farmers interested, and for those who desire to enter upon this work the following details are given:

Potato Tillage Experiments.

Select, if possible, a loamy soil avoiding light sands or heavy clay. If a clover sod can be plowed under it will serve the purpose well, but heavy, tenacious sods should be avoided. Select a place on which the soil is uniform in quality and all portions of which have been treated alike as regards cropping and ma-

nuring. Plow immediately, or as early as the condition will permit, and measure off the plats which are to be devoted to the experiment. It is desired that this be an experiment to determine the effect of tillage upon potatoes, and the following suggestions as to size and number of plats are given to aid the farmer in carrying out the purpose of this work. (See diagram.) Measure off a piece of land 207½ feet long and 147 feet wide. (A space of at least three feet should be allowed outside of the outer rows, indicated by the outside solid black lines, so that cultivation may be given to both sides of the potato rows. This will give the total width over all of an additional 6 feet or 153 feet.) Divide this up into six plats, each 24½ feet wide and 207½ feet long. This will provide for six rows of potatoes 3½ feet apart to each plat, and will leave a space of 3½ feet between the outside experiment rows and the edge of the plats. A space of seven feet will be left between the adjacent rows of the plats, and in this space there should be a row of potatoes planted which is to be dug before the other six rows on the plat are harvested. This extra row is indicated by the solid black lines in the diagram, and the rows of potatoes which are to enter into the experiment are indicated by the dotted lines. Planted in this way there will be one-tenth of an acre of potatoes to each plat. If it is desired to have the plats only half the size of the ones shown in the diagram, then instead of making them 207½ feet long, make them only half that length or 103 feet 9 inches long and the width the same, 24½ feet, and plant the rows the same distance apart as indicated above, 3½ feet. This will give plats of one-twentieth of an acre each. If the circumstances are such that it seems desirable to have the rows of greater length and not have the plats definitely marked off, as in the diagram, it may be done by so measuring the rows that a total of 1,245 feet in each plat shall be subject to the special tillage desired. This will give a potato area of one-tenth of an acre. If the smaller area of one-twentieth of an acre is preferred then have a total length of rows in each plat of 622½ feet. Where the plan of the diagram can be followed it is recommended so that there may be as great a uniformity of methods and results as possible. Eight additional feet should be allowed

DIAGRAM FOR POTATO PLATS.



Plats 207½ ft. long; 24½ ft. wide.
Six rows of potatoes to the plat.

Plat 1—3 cultures.
" 2—6 cultures.
Plat 3—9 cultures.
" 4—3 cultures.
Plat 5—6 cultures.
" 6—9 cultures.

at each end of the plats for turning room, making the total length of the potato rows 223½ feet, so that during tillage that portion which is to enter into the experiment will not be injured by the tramping of horses in turning. At time of digging, eight feet at each end and the extra rows planted between plats (indicated in diagram by the solid black lines) should be dug and removed before the experiment plats are harvested.

After plowing the land this spring harrow thoroughly, breaking all clods and pulverizing the soil. Open the rows with a shovel, plow or with a double moldboard plow. Cut the potatoes so that there shall be one or two strong eyes to the piece, each piece being of good size, and drop one piece to a place and 14 inches apart in the row. Cover with a hoe to the depth of about four inches. The seed should be uniform and of the same variety. If any traces of scab are present, the potatoes should be soaked before cutting for one hour in solution of two ounces of corrosive sublimate to thirteen gallons of water. This corrosive sublimate is poison and should be handled with extreme care. Prof. J. C. Arthur, of Purdue University Experiment Station, Indiana, recommends for potato scab eight fluid ounces of Commercial Formalin (which can be purchased at the drug store) to fifteen gallons of water. Immerse the potatoes for two hours. This is perfectly safe and said to be thoroughly efficient. Before the potatoes are up, about one week after planting, thoroughly harrow all plats with a spike tooth harrow. If a heavy rain should come after this harrowing and before potatoes are up, use the harrow again on all plats, breaking up the surface soil crust. When potatoes are up so that the rows can be followed, cultivate all plats with a fine tooth implement. A spring-tooth cultivator does the work well. After this first tillage plat 1 is to have but two more cultures, plat 2 five more and plat 3 eight more. Repeat with plats 4, 5 and 6. All this is to be level culture and no hilling up. Plats will then receive tillage as follows:

Plat 1—3 cultivations.	Plat 4—3 cultivations.
" 2—6 "	" 5—6 "
" 3—9 "	" 6—9 "

The foliage on all plats must be kept intact by spraying if necessary. To prevent the attacks of the leaf flea-beetle and the blight use Bordeaux mixture, and for the common potato beetle, Paris-green. (See Cornell Bulletin 130.)

If it is desired to conduct fertilizer experiments in connection with this tillage experiment, the additional plats required may be laid off the same size and the fertilizer applied according to directions given by Dr. Caldwell. (See Cornell Bulletin 129.) It is hoped that, in addititon to the potato tillage experiment outlined above, every farmer will arrange for one or more additional plats on which to carry out his own idea of potato raising. Have one plat which shall have the potatoes hilled up in the ordinary way of hilling potatoes.

RECORD OF POTATO EXPERIMENT, 1897.—TO BE RETURNED AT THE END OF THE SEASON TO CHIEF CLERK, COLLEGE OF AGRICULTURE, ITHACA, N. Y.

Name of Experimenter..................

Post Office..........................

County.........................

Kind of soil..

Previous treatment of land...........................

Date of plowing...

Manner of fitting land................................

Size of plats ....

Name of variety planted............................

Date of planting..

Dates of harrowing....................................

Plat 1:

Date of first tillage . . . .

Date of second tillage . . . .

Date of third tillage . . . .

Date of digging . . . .

Weight of marketable potatoes . . . .

Weight of small potatoes . . . .

Remarks:

Dates of spraying . . . .

Rainfall . . . .

Kind of implement used in tilling, etc. . . . .

Plat 2:

Date of first tillage . . . .

Date of second tillage . . . .

Date of third tillage . . . .

Date of fourth tillage . . . .

Date of fifth tillage . . . .

Date of sixth tillage . . . .

Date of digging . . . .

Weight of marketable potatoes . . . .

Weight of small potatoes . . . .

Remarks:

Plat 3:

Date of first tillage ....

Date of second tillage ....

Date of third tillage..............................

Date of fourth tillage ....

Date of fifth tillage ....

Date of sixth tillage..............................

Date of seventh tillage..............................

Date of eighth tillage ....

Date of ninth tillage ....

Date of digging ....

Weight of marketable potatoes ....

Weight of small potatoes ....

Remarks:

Plat 4:

Date of first tillage ....

Date of second tillage..............................

Date of third tillage..............................

Date of digging..............................

Weight of marketable potatoes..............................

Weight of small potatoes ....

Remarks:

Plat 5:

Date of first tillage..
Date of second tillage..
Date of third tillage..
Date of fourth tillage..
Date of fifth tillage..
Date of sixth tillage..
Date of digging..
Weight of marketable potatoes..
Weight of small potatoes..

Remarks:

Plat 6:

Date of first tillage..
Date of second tillage..
Date of third tillage..
Date of fourth tillage..
Date of fifth tillage..
Date of sixth tillage..
Date of seventh tillage..
Date of eighth tillage..
Date of ninth tillage..
Date of digging..
Weight of marketable potatoes..
Weight of small potatoes..

Remarks:

EXTRA PLATS FOR SPECIAL EXPERIMENT ON HILLING.

State fully the treatment given and the weight of marketable and small potatoes harvested.

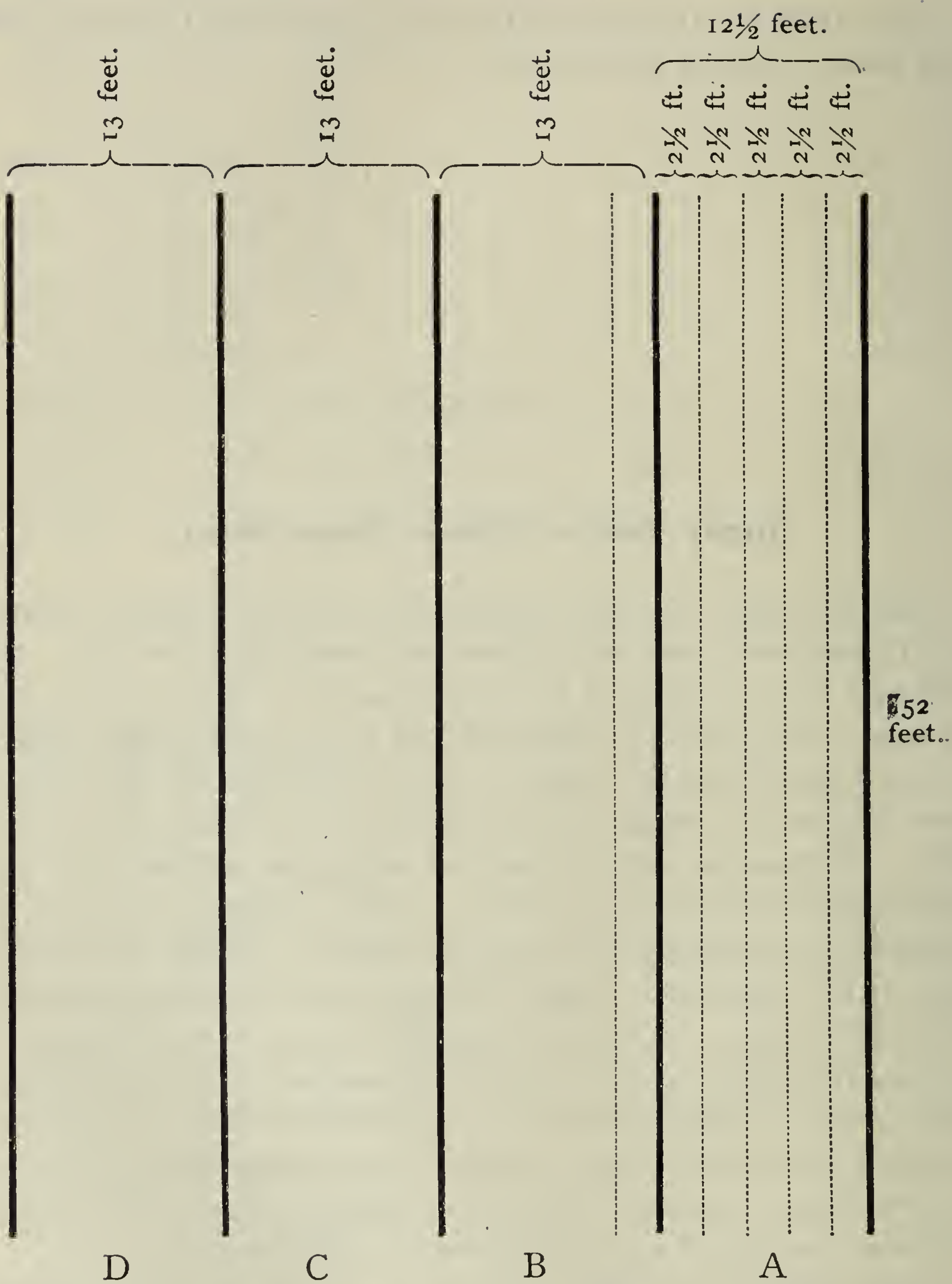
Sugar Beets—Tillage Experiment.

Enough sugar beet seed will be sent by the Cornell University Experiment Station to plant one-twentieth of an acre. All who wish to co-operate in the experiment are requested to write for seed, which will be distributed as long as the supply lasts.

It is desired that the plats be laid off as follows (See Sugar Beet diagram). Measure off an area 52 feet long and 50 feet wide. In plowing add 2½ feet to each side, making the total area to be plowed 57 by 55 feet. This additional area to be plowed is for the purpose of giving room for tillage on the outside of the outer row. Stake off four plats each 12½ feet wide and 52 feet long. This will provide for four rows of beets to the plat (indicated by the dotted lines) and an extra row between and outside of plats (indicated by solid black lines). These extra rows are not to enter into the experiment and are to be harvested and removed before the regular four rows of the experiment (indicated by dotted lines) are harvested.

The following directions regarding sugar beet culture may be found helpful. An open porous soil, not over sandy, should be selected avoiding heavy clay subsoils or hardpan. While the soil should be fertile yet fresh barn manure should not be applied. Where it is desired to fertilize with barn manure it should be

SUGAR BEET DIAGRAM.



Four plats 52 feet long; 12½ feet wide, 4 rows to plat, 2½ feet between rows. Area of each plat, $\frac{1}{80}$ acre.

applied and plowed under in the fall. Muck or bottom land soils while they might produce a large amount of beets, yet the percentage of sugar would probably be low. Select well drained upland, loamy soil or one with a fairly porous subsoil. This will enable the beet to expand evenly and produce a smooth, regularly developed root. Plow deep and early, harrow once and then allow the land to remain without being disturbed for a few days. This is to permit whatever weed seed may be in the soil to sprout before planting the beets. Then harrow again thoroughly and if heavy rains have packed the soil, make it loose again with a cultivator or by shallow gang plowing. After fining and pulverizing with the harrow use the roller and follow the roller with a light, fine tooth harrow. This fitting should be done just previous to planting the seeds.

Mark off the rows by stretching a line across the plats, rows to be 2½ feet apart. (See diagram for beets.) The two packages of beet seed sent are sufficient to plant four plats of the dimensions given in the diagram. Planting in this latitude may usually be done from the first to the middle of May. Cover the seed to a depth of about one inch and firm the earth over the rows by means of a rake, leaving it firm but not packed smoothly.

If weeds and grass start before the beets are up then hand work must be resorted to, for it is absolutely essential that the weeds be kept in check and the easiest way to do this is to check them at the start. Should heavy rains cause a surface soil crust to be formed, this crust must be broken up either by using a rake or some light implement similar to a Breed's weeder. As soon as the rows can be followed horse tillage should commence, the implement used being one with many fine teeth (similar to one shown in frontispiece of Cornell Bulletin 130).

This experiment is one of tillage alone. (The fertilizer experiments are described by Dr. Caldwell in Bulletin 129.) As soon as the rows can be followed give all plats tillage with the fine tooth implement. After the first time the tillage of the plats is to vary in frequency. Plats A and C (see diagram) are to receive tillage about every seven days and plats B and D only about every fourteen days, so that every other time all plants

will receive tillage. If weeds or grass appear in the row they must be removed by hand.

Thinning should be done as soon as four leaves are formed. This work must not be delayed until the plants become of considerable size or the roots will so interlace that injury will be done to the ones we wish to leave. In thinning large areas the work is done by chopping out with a hoe, leaving a bunch every nine inches, and then thinning out the bunch by hand. On these small plats the thinning would better all be done by hand. Leave a strong, vigorous plant every nine or ten inches. Press the earth firmly around the plants left but do not hill up. The pressure should not be great enough to injure the cells of the plant.

Harvesting should be done before heavy frost. It also should be done before the tops begin making a second growth. The samples selected to be sent to Cornell University for analysis should be of medium size, not the largest nor smallest but a good average of the lot. The rows indicated in the diagram by the solid black lines should be harvested before the main plats and the beets removed. Then harvest and weigh each plat of four rows. Take as a sample, five average sized beets, put them in a sack and put in the sack with them the record as to culture and yield of the plat. Tie the sack securely and put in a box. In this way take and prepare samples of all the plats, putting in the sack with the sample the record of the plat on which the sample was grown. The following blank form may be used in keeping and reporting the record of the plats:

This is to be returned at the end of the season to CHIEF CLERK, COLLEGE OF AGRICULTURE, Ithaca, N. Y.

Name of Experimenter ....

Post Office ....

County ....

Kind of land ....

Previous treatment of land ....

Date of plowing ....

Manner of fitting ....

Date of planting ....

Treatment after planting before plants are up............

Date of first tillage of all plats ....

PLAT A	PLAT B
(To be tilled about every 7 days.)	(To be tilled one-half as many times as Plat A. About every 14 days.)
Dates of Tilling.	*Dates of Tilling.*
Date harvested	Date harvested ....
Weight of beets.............	Weight of beets.............

PLAT C	PLAT D
(To be tilled same as A.)	(To be tilled same as B.)
Dates of Tilling.	*Dates of Tilling.*
Date harvested	Date harvested ....
Weight of beets.............	Weight of beets.............

I. P. ROBERTS, Director.
L. A. CLINTON, Asst. Agriculturist.

CIRCULAR CONCERNING

Co-Operative Tillage Experiments.

No. 6.

Cornell University,
College of Agriculture.

Ithaca, N. Y., April 15, 1897.

Directions for the Application of the Fertilizers and Records to be Made.

Since so many applications have been made for fertilizers to be used in the "Field Experiments," we have limited the size of plats to be experimented upon to $\frac{1}{20}$ of an acre each. We have sent you by freight one large sack containing ten small sacks, each tagged so that you can tell what kind and how much fertilizer each small sack contains.

Pay *no attention* whatever to any printing that may be upon the sacks, but give *strict attention to the tags* that are tied to the bags. The contents of the small sacks are to be applied to the plats as follows:

On Plat **K** put contents of one sack containing 10 pounds Muriate of Potash.

On Plat **N** put contents of one sack containing 10 pounds Nitrate of Soda.

On Plat **KN** put contents of one sack containing 10 pounds Muriate of Potash, also contents of one sack containing 10 pounds Nitrate of Soda.

On Plat **P** put contents of one sack containing 20 pounds Superphosphate.

On Plat **KP** put contents of sack containing a mixture of 10 pounds Muriate of Potash and 20 pounds Superphosphate.

On Plat **NKP** put contents of one sack containing 10 pounds Nitrate of Soda, also contents of sack containing a mixture of 10 pounds Muriate of Potash and 20 pounds Superphosphate.

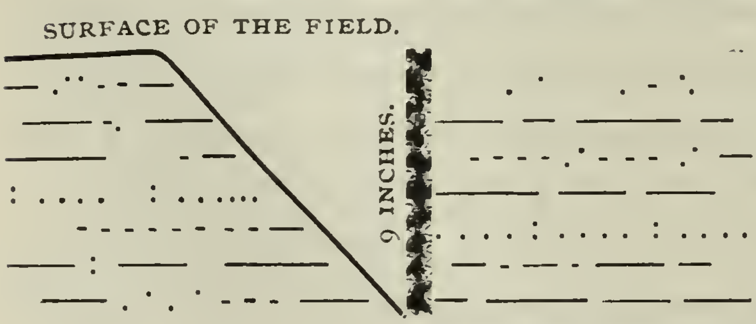
On Plat **NP** put contents of one sack containing 10 pounds Nitrate of Soda, also contents of one sack containing 20 pounds Superphosphate.

Apply the Muriate of Potash and the Superphosphate before the crops are planted and the Nitrate of Soda later. Do not apply the Nitrate of Soda on the plats requiring it until the crops have been planted and have been up about fifteen days; then apply half of the Nitrate as a surface dressing and three weeks later apply the rest and cultivate in.

For corn, or potatoes and such crops that are to be in hills or rows, throw a furrow each way so as to leave a shallow trench. Put the fertilizers (only the Phosphate or Muriate of Potash, or the mixture of the two) in the bottom of this trench; then cover very lightly. A light, fine toothed cultivator may be used for this. This is to prevent the seed from coming in contact with the concentrated fertilizer, which might be injurious to it. Plant the potatoes, or corn, or whatever the crop is, on top of this covered fertilizer and from this point proceed in the ordinary way.

If fertilizers are applied to grapes, berries, etc., in rows, apply along each side of the rows on the surface, and then cultivate in and mix with the surface soil. For any crop that is sown broadcast, apply the fertilizer broadcast and cultivate in. If fine, well rotted stable manure is used on one plat, spread broadcast after land is plowed and cultivate in. If the manure is coarse, spread broadcast and plow it under. If not plowed under it will be more or less in the way all summer.

Sampling the Soil.



The first thing to do before applying the fertilizer is to get a good average sample of soil from that portion of the field on which the plats are laid out.

Proceed as follows: Sample that portion of the field in from 10 to 15 different places. With a spade with a square end dig a hole, the width of the spade and nine inches deep, leaving one side of the hole vertical and the other side sloping just as in the cut. Clean out all the loose soil at the bottom of the hole; cut off from the vertical side a slice about two inches thick from top

to bottom, the full width of the spade and save this slice to represent one of the partial samples. Pick out all stones larger than ¼ to ½ inch in diameter.

These 10 to 15 small samples are to be mixed together in a large box or on some clean boards. These several partial samples when mixed will make from 1 to 1½ bushels of soil. Mix thoroughly by stirring and shoveling over and over a number of times; then of this *thoroughly* mixed soil take a sample of *three pecks* and put it into the large sack that held the small sacks of fertilizer. Tie it up tightly and keep until further notice. To be of any use for analysis or experiments at the Experiment Station, this sample *must* represent as accurately as possible the whole area to be divided up into the nine plats, before the fertilizers have been applied.

Make a record as complete as possible of the field according to the following plan:

I—*Location of Field.*

- a—Upland.
- b—Lowland. (If lowland, do side hills wash down upon it?)
- c—Hillside, etc.

II—*Character of Soil.*

- a—Sandy.
- b—Gravelly.
- c—Clayey.
- d—Loamy, etc.
- e—How deep is surface soil?
- f—Is there a hard pan; if so, how deep?
- g—Does soil hold moisture, or dry out rapidly?

III—*Fertility of Soil.*

- a—Does soil possess the required amount of plant-food or does it "run down" quickly and need enriching?
- b—Have manures or fertilizers been applied in past years? If so, how often, what kinds and how often, what kinds and how much per acre?

IV—*History of Crops Previous to* 1897.

What crops have been grown and how much yield per acre in past years? In case of cereals give number of bushels of grain and tons of straw or stalks per acre.

V—*History of Crop for* 1897.

Kind of crop grown.

Date of planting.

Date when crop begins to come up on each plat.

Date when crop is about half up on each plat.

Date when crop is practically all up on each plat.

From time to time keep note of any differences that may appear between the various plats.

SAMPLE RECORD.

I. c—Hillside.

II. b—Gravelly.

III. a—Runs down quickly and needs plant food.

IV. Pasture for eight years, then two years corn—50 bushels corn per acre and three-fourths ton stalks each year, etc.

V. Keep notes of time of planting, etc., as suggested in V under History of Crop for 1897.

SUGGESTIONS.

The same kind and same amount of seed is to be sown on each of the series of eight or nine plats in the set. Drive stakes in such a way, and so number the plats that there will be no danger of getting the several plats mixed and so cause confusion. It must be remembered that this experiment is to be tried upon the crop planted and not upon an accidental crop of weeds. In no case will the experiment be of value if the weeds are allowed to grow upon the plats. Thorough cultivation is one of the most important features of the field test.

It will be impossible to send an agent to inspect each series of experiments, but if you become very much confused and do not understand the instructions given, let us know and we will try to help you out either by correspondence or by sending an agent to your place.

APPENDIX II.

Detailed statement of receipts and expenditures of the Cornell University Agricultural Experiment Station, for the fiscal year ending June 30th, 1897.

RECEIPTS.

FROM AGRICULTURAL DIVISION.

1896.				
Nov.	25.	Products sold (Farm)	$34 00	$34 00

FROM HORTICULTURAL DIVISION.

1896.				
July	2.	Sundry fruits	4 55	
Nov.	24.	Sundry fruits	33 07	
1897.				
Jan.	6.	Hauling coal	2 96	
"	6.	Sundry fruits	4 00	
"	15.	Sundry fruits	20 76	
Feb.	6.	Sundry fruits	20 55	
June	23.	Sundry fruits	3 65	89 54

FROM OFFICE.

1896.				
Nov.	7.	Spray Calendars	2 00	
1897.				
Apr.	5.	Spray Calendars	33 75	35 75
		Grand Total		$159 29

EXPENDITURES.

FOR SALARIES.

1896.			
July	31.	I. P. Roberts, Director, 1 mo.	$125 00
"	31.	H. H. Wing, Dairyman, 1 mo	104 24
"	31.	G. F. Atkinson, Botanist, 1 mo	91 74
"	31.	G. W. Cavanaugh, Assistant Chemist, 1 mo.	83 33
"	31.	L. A. Clinton, Assistant Agriculturist, 1 mo	83 33
"	31.	E. A. Butler, Clerk, 1 mo	50 00
Aug	31.	I. P. Roberts, Director, 1 mo.	125 00
"	31.	H. H. Wing, Dairyman, 1 mo	104 24
"	31.	G. F. Atkinson, Botanist, 1 mo	91 74
"	31.	G. W. Cavanaugh, Assistant Chemist, 1 mo.	83 33
"	31.	L. A. Clinton, Assistant Agriculturist, 1 mo.	83 33
Sept.	30.	I. P. Roberts, Director, 1 mo.	125 00
"	30.	H. H. Wing, Dairyman, 1 mo	104 00
"	30.	G. F. Atkinson, Botanist, 1 mo.	91 74
		Amount carried forward	$1,346 02

		Amount brought forward	$1,346 02
Sept.	30.	G. W. Cavanaugh, Assistant Chemist, 1 mo.	83 33
"	30.	L. A. Clinton, Assistant Agriculturist, 1 mo.	83 33
"	30.	E. A. Butler, Clerk, 1 mo	50 00
Oct.	31.	I. P. Roberts, Director, 1 mo	125 00
"	31.	L. H. Bailey, Horticulturist, 1 mo	166 66
"	31.	H. H. Wing, Dairyman, 1 mo	104 16
"	31.	M. V. Slingerland, Assistant Entomologist, 1 mo	125 00
"	31.	G. F. Atkinson, Botanist, 1 mo	91 66
"	31.	G. W. Cavanaugh, Assistant Chemist, 1 mo.	83 33
"	31.	L. A. Clinton, Assistant Agriculturist, 1 mo.	83 33
Nov.	30.	I. P. Roberts, Director, 1 mo	125 00
"	30.	L. H. Bailey, Horticulturist, 1 mo	166 66
"	30.	H. H. Wing, Dairyman, 1 mo	104 16
"	30.	M. V. Slingerland, Assistant Entomologist, 1 mo	125 00
"	30.	G. F. Atkinson, Botanist, 1 mo.	91 66
"	30.	G. W. Cavanaugh, Assistant Chemist, 1 mo	83 33
"	30.	L. A. Clinton, Assistant Agriculturist, 1 mo	83 33
"	30.	E. A. Butler, Clerk, 1 mo	50 00
Dec.	31.	I. P. Roberts, Director, 1 mo.	125 00
"	31.	L. H. Bailey, Horticulturist, 1 mo	166 66
"	31.	H. H. Wing, Dairyman, 1 mo	104 16
"	31.	M. V. Slingerland, Assistant Entomologist, 1 mo	125 00
"	31.	G. F. Atkinson, Botanist, 1 mo	66 67
"	31.	G. W. Cavanaugh, Assistant Chemist, 1 mo.	83 33
"	31.	L. A. Clinton, Assistant Agriculturist, 1 mo.	83 33
1897.			
Jan.	31.	I. P. Roberts, Director, 1 mo.	$125 00
"	31.	L. H. Bailey, Horticulturist, 1 mo	166 66
"	31.	H. H. Wing, Dairyman, 1 mo	104 16
"	31.	M. V. Slingerland, Assistant Entomologist, 1 mo	125 00
"	31.	G. F. Atkinson, Botanist, 1 mo	83 33
"	31.	G. W. Cavanaugh, Assistant Chemist, 1 mo.	83 33
"	31.	L. A. Clinton, Assistant Agriculturist, 1 mo.	83 33
"	31.	E. A. Butler, Clerk, 1 mo	50 00
Feb.	28.	I. P. Roberts, Director, 1 mo	125 00
"	28.	L. H. Bailey, Horticulturist, 1 mo	166 66
"	28.	H. H. Wing, Dairyman, 1 mo	104 16
"	28.	M. V. Slingerland, Assistant Entomologist, 1 mo	125 00
"	28.	G. F. Atkinson, Botanist, 1 mo	83 33
"	28.	G. W. Cavanaugh, Assistant Chemist, 1 mo.	83 33
"	28.	L. A. Clinton, Assistant Agriculturist, 1 mo.	83 33
Mar.	31.	I. P. Roberts, Director, 1 mo.	125 00
"	31.	L. H. Bailey, Horticulturist, 1 mo	166 66
"	31.	H. H. Wing, Dairyman, 1 mo	104 16
"	31.	M. V. Slingerland, Assistant Entomologist, 1 mo	125 00
"	31.	G. F. Atkinson, Botanist, 1 mo	83 33
"	31.	G. W. Cavanaugh, Assistant Chemist, 1 mo	83 33
"	31.	L. A. Clinton, Assistant Agriculturist, 1 mo	83 33
Apr.	30.	I. P. Roberts, Director, 1 mo	125 00
"	30.	L. H. Bailey, Horticulturist, 1 mo	125 00
"	30.	H. H. Wing, Dairyman, 1 mo	52 08
"	30.	G. F. Atkinson, Botanist, 1 mo	83 33
"	30.	G. W. Cavanaugh, Assistant Chemist, 1 mo	83 33
		Amount carried forward	$6,756 28

		Amount brought forward	$6,756 28
Apr.	30.	L. A. Clinton, Assistant Agriculturist, 1 mo	83 33
"	30.	E. A. Butler, Clerk, 1 mo	50 00
May	31.	I. P. Roberts, Director, 1 mo.	125 00
"	31.	L. H. Bailey, Horticulturist, 1 mo	125 00
"	31.	H. H. Wing, Dairyman, 1 mo	52 08
"	31.	G. F. Atkinson, Botanist, 1 mo	83 33
"	31.	G. W. Cavanaugh, Assistant Chemist, 1 mo	83 33
"	31.	L. A. Clinton, Assistant Agriculturist, 1 mo	83 33
"	31.	E. A. Butler, Clerk, 1 mo	50 00
June	30.	I. P. Roberts, Director, 1 mo	125 00
"	30.	L. H. Bailey, Horticulturist, 1 mo	125 00
"	30.	H. H. Wing, Dairyman, 1 mo	52 08
"	30.	G. F. Atkinson, Botanist, 1 mo	83 33
"	30.	G. W. Cavanaugh, Assistant Chemist, 1 mo	83 33
"	30.	L. A. Clinton, Assistant Agriculturist, 1 mo	83 33
		Total for Salaries	$8,043 75

FOR PRINTING.

1896.			
Aug.	31.	W. F. Humphrey, 12,000 copies Bulletin No. 118	$48 80
"	31.	W. F. Humphrey, 6 aditional pages Bulletin No. 117, 12,000	38 40
"	31.	U. S. Express Co., Expressage	25
Sept.	3.	L. V. R. R. Co., Freight	1 12
"	3	L. V. R. R. Co., Freight	1 07
"	4.	Andrus & Church, 5,000 Cards Printed	7 25
"	8.	L. V. R. R. Co., Freight	2 76
Oct.	12.	Western Union Telegraph Co., Telegram	25
Nov.	7.	L. V. R. R. Co., Freight	56
"	19.	U. S. P. O., Stamps	10 00
Dec.	7.	U. S. Express Co., Expressage	45
"	15.	U. S. Express Co., Expressage	25
1897.			
Jan.	27.	U. S. Express Co., Expressage	80
Feb.	2.	U. S. Express Co , Expressage	1 50
"	10.	U. S. Express Co., Expressage	30
"	16.	L. V. R. R. Co., Freight	11 17
"	16.	L. V. R. R. Co., Freight and Cartage	66
"	16.	L. V. R R. Co., Freight and Cartage	2 48
"	17.	U. S. Express Co., Expressage	65
"	20.	U. S. Express Co., Expressage	65
"	22.	U. S. Express Co., Expressage	65
"	25.	Franklin Engraving Co., 5 half-tone Cuts	19 75
"	25.	Franklin Engraving Co., 5 half-tone Cuts	18 00
"	26.	U. S. Express Co., Expressage	1 05
Mar.	31.	J. H. McFarland Co., 1 half-tone Cut	3 50
"	31.	H. T. Anthony & Co., 1,500 Negative Prints	3 95
Apr.	8.	L. V. R. R. Co., Freight	93
"	14.	W. F. Humphrey, 20,000 copies Bulletin No. 130	162 20
"	20.	U. S. Express Co., Expressage	70
"	24.	C. W. Sims, Labor	5 00
May	3.	L. V. R. R. Co., Freight and Cartage	61
"	10.	L. V. R. R. Co., Freight and Cartage	1 07
		Amount carried forward	$346 78

		Amount brought forward	$346 78
May	10.	L. V. R. R. Co., Freight and Cartage	1 34
"	25.	L. V. R. R. Co., Freight and Cartage	3 63
		Total for Printing	$351 75

FOR OFFICE EXPENSES.

1896.			
July	1.	E. S. Tichenor, Furniture	$13 00
"	7.	E. A. Butler, Supplies	65
"	13.	U. S. Express Co., Expressage	55
"	13.	Andrus & Church, Stationery and Supplies	3 90
"	13.	M. A. Adsitt, Stationery	2 50
"	13.	Lovejoy Co., Expressage on Cut	25
"	29.	L. V. Maloney, Labor	40 50
"	30.	Treman, King & Co., Supplies	1 79
"	30.	Western Union Telegraph Co., Telegram	50
Aug.	1.	Andrus & Church, Stationery	1 50
"	3.	Western Union Telegraph Co., Telegrams	16 50
"	20.	Lovejoy Co., 1 half-tone Cut and Postage	5 09
"	20.	Andrus & Church, 1 doz. Pencils	40
"	20.	M. A. Adsitt, Typewriter Ribbon	1 00
"	20.	Ithaca *Journal*, Envelopes	18 75
"	20.	U. S. P. O., Stamps	10 00
"	31.	L. V. Maloney, Labor	39 00
"	31.	W. C. Bell, Labor	15 00
Sept.	4.	Treman, King & Co., Supplies	90
"	8.	M. A. Adsitt, Typewriter Ribbon and Stationery	2 30
"	15.	U. S. P. O., Stamps	10 00
"	17.	Andrus & Church, Mucilage	1 00
"	21.	Rand, McNally Co., Atlas (2 Vols.)	28 50
"	25.	W. C. Bell, Labor	4 80
"	25.	Andrus & Church, Rubber Bands	25
"	30.	L. V. Maloney, Labor	39 00
"	30.	Andrus & Church, Ink and Pins	20
"	30.	Andrus & Church, Scrap Book	80
Oct.	6.	Andrus & Church, Letter Opener	35
"	16.	E. G. Hance, Cartage	50
"	19.	Andrus & Church, Sundry Supplies	1 67
"	19.	Andrus & Church, Day Book and Ledger	3 30
"	23.	Andrus & Church, Reading Glass	60
"	28.	J. M. Hovey, Labor	1 60
"	29.	Andrus & Church, Bristol-board	48
"	31.	L. V. Maloney, Labor	40 50
"	31.	John Gilmore, Labor	75
"	31.	C. B. Tailby, Labor	2 85
"	31.	G. W. Tailby, Labor	4 10
Nov.	5.	M. A. Adsitt, Letter Book and Delivery	2 90
"	7.	U. S. P. O., Stamps	10 00
"	11.	U. S. Express Co., Expressage	60
"	17.	Wm. J. Campbell, Books	1 50
"	17.	M. A. Adsitt, Stationery	2 20
"	17.	Andrus & Church, Supplies	20
"	18.	M. A. Adsitt, Supplies	1 10
		Amount carried forward	$333 83

		Amount brought forward	$333 83
Nov.	21.	W. J. Campbell, Book	1 25
"	24.	A. B. Brooks, Sundry Supplies	2 25
"	30.	L. V. Maloney, Labor	37 50
Dec.	7.	Andrus & Church, Stationery	2 23
"	8.	Ithaca Plumbing Co., 6 Chimneys	60
"	15.	Andrus & Church, 5,000 printed Letter Heads	17 50
"	22.	B. F. White, Photographs	25 05
"	23.	U. S. P. O., Stamps	10 00
"	29	L. V. Maloney, Labor	40 50
"	30.	G. W. Tailby, Labor	70
"	30.	C. B. Tailby, Labor	33
"	30.	A. B. Kennedy, Repairing Clock	1 20
1897.			
Jan.	5.	Western Union Telegraph Co., Telegram	33
"	9.	Andrus & Church, Stationery	2 85
"	12.	Ithaca Gas Co , Gas	2 08
"	12.	Treman, King & Co., Supplies	1 45
"	15.	U. S. P. O., Stamps	10 00
"	15.	Lovejoy Co., Cuts and Engraving	2 28
"	15.	I. P. Roberts, Traveling Expenses	2 25
"	15.	Andrus & Church, Cardboard	1 20
"	16.	L. V. R. R. Co., Freight and Cartage	6 74
"	19.	A. A. A. C. & E. S., Membership Fee	10 00
"	26.	Andrus & Church, Printing 300 Postal Cards	75
"	26.	U. S. Express Co., Expressage	1 50
"	30.	L. V. Maloney, Labor	39 00
Feb.	5.	Western Union Telegraph Co., Telegrams	1 50
"	5.	W. J. Harris, Labor	1 00
"	11.	John Gilmore, Labor	1 65
"	13.	U. S. Express Co., Expressage	80
"	15.	L. V. R. R. Co., Freight and Cartage	62
"	18.	U. S. Express Co., Expressage	40
"	20.	Ithaca Gas Co., Gas	1 12
"	22.	W. H. Carver, Pens	1 50
"	23.	U. S. Express Co., Expressage	55
"	24.	E. G. Hance, Cartage	85
"	25.	Andrus & Church, Supplies	1 75
"	25.	Andrus & Church, Stationery	2 85
"	26.	L. V. Maloney, Labor	36 00
"	27.	C. B. Tailby, Labor	2 79
"	27.	G. W. Tailby, Labor	3 64
"	27.	John Gilmore, Labor	4 05
Mar.	6.	M. A. Adsitt, Supplies	2 20
"	7.	L. V. R. R. Co., Freight and Cartage	5 50
"	8.	M. V. Slingerland, Traveling Expenses	27 95
"	17.	Ithaca Gas Co., Gas	80
"	17.	Andrus & Church, Rule	50
"	17.	Ithaca Stamp Co , Rubber Stamp	2 50
"	18.	W. J. Harris, Sign	5 50
"	18.	I. P. Roberts, Traveling Expenses	16 19
"	29.	Cornell Co-op. Society, Supplies	15 03
"	29.	L. V. Maloney, Labor	40 50
"	31.	G. W. Tailby, Labor	5 12
"	31.	C. B. Tailby, Labor	3 75
		Amount carried forward	$739 98

		Amount brought forward	$739 98
Mar.	31.	M. A. Adsitt, Sundry Supplies and Stationery	6 55
Apr.	1.	John Gilmore, Labor	14 25
"	5.	U. S. P. O., Stamps	10 00
"	12.	Andrus & Church, Supplies	30
"	21.	Carrie Gaylord, Labor	9 10
"	24.	U. S. P. O., Stamps	10 00
"	30.	L. V. Maloney, Labor	39 00
"	30.	G. W. Tailby, Labor	8 76
"	30.	C. B. Tailby, Labor	5 00
"	30.	L. E. Shanks, Labor	2 85
May	1.	C. H. Howes, Camera and Fixtures	34 90
"	3.	John Gilmore, Labor	12 60
"	4.	S. J. Druskin, Labor	1 50
"	18.	Ithaca Gas Co., Gas	64
"	20.	U. S. P. O., Stamps	10 00
"	22.	Andrus & Church, Stationery	3 75
"	29.	L. V. Maloney, Labor	39 50
June	1.	Wm. McGraime, Labor	1 00
"	3.	Andrus & Church, Stationery	1 75
"	9.	M. A. Adsitt, Note Books	1 50
"	12.	Co-op. Society, Sundry Supplies	5 93
"	14.	Lucy Custis, Labor	10 88
"	15.	Carter Ink Co., 4 Ribbons	4 50
"	19.	Andrus & Church, Supplies	40
"	19.	M. Gaylord, Labor	3 45
"	23.	M. A. Adsitt, Stationery	1 20
"	23.	John Gilmore, Labor	8 40
"	29.	L. V. Maloney, Labor	38 50
"	30.	Andrus & Church, 2 M Envelopes	2 90
		Total for Office Expenses	$1,029 09

FOR AGRICULTURAL DIVISION.

1896.			
July	17.	White & Burdick, Chemicals	1 80
"	20.	Andrus & Church, Sundry Supplies	1 85
"	21.	U. S. Express Co., Expressage	90
"	24.	Andrus & Church, Supplies	12 75
"	29.	Treman, King & Co., Supplies	4 80
"	31.	B. F. White, Photographs	10 50
Aug.	3.	Fuertes Pharmacy, Chemicals	8 06
"	20.	Driscoll Bros. & Co., Lime	1 50
"	20.	J. W. Hills, Lantern Slides	18 50
"	31.	A. T. Stout, Labor	40
"	31.	C. B. Tailby, Labor	1 60
"	31.	G. W. Tailby, Labor	3 01
"	31.	C. W. Sims, Labor	29 70
"	31.	H. W. Badger, Labor	13 24
"	31.	J. Shimada, Labor	31 63
Sept.	3.	L. V. R. R. Co., Freight	2 71
"	3.	D. L. & W. R. R. Co., Freight and Cartage	60
"	8.	O. A. C. Agr. College, Wheat	2 90
"	14.	U. S. P. O., Stamped Envelopes	21 60
"	26.	L. V. R. R. Co., Freight and Cartage	4 18
"	30.	A. T. Stout, Labor	2 88
		Amount carried forward	$175 11

		Amount brought forward	$175 11
Sept.	30.	L. Harrington, Labor	10 47
"	30.	C. B. Tailby, Labor	2 70
"	30.	G. W. Tailby, Labor	2 73
Oct.	3.	U. S. Express Co., Expressage	75
"	19.	White & Burdick, Chemicals	2 55
"	24.	L. V. R. R. Co., Freight	45
"	29	Treman, King & Co., Tape Line	1 25
"	30.	Syracuse Pottery Co., Pots and Saucers	9 00
"	31.	G. S. Hall, Pig	15 00
"	31.	L. Harrington, Labor	21 00
"	31.	S. Raub, Labor	16 50
"	31.	A. J. Briggs, Labor	6 15
"	31.	John Gilmore, Labor	4 58
"	31.	J. Shimada, Labor	3 75
"	31.	National Express Co., Expressage	3 05
Nov.	5	Tremen, King & Co., Twine	25
"	5.	L. Roesch, Grape Cuttings	1 07
"	7.	L. V. R. R. Co., Freight and Cartage	1 18
"	9.	Enz & Miller, Stationery	2 37
"	28.	L. V. R. R. Co., Freight and Cartage	1 59
"	30.	Theodore VanAtta, Labor	35 87
"	30.	S. Raub, Labor	21 75
"	30.	L. Harrington, Labor	21 00
"	30.	A. J. Briggs, Labor	7 20
"	30.	G. W. Tailby, Labor	1 95
"	30.	C. B. Tailby, Labor	1 53
"	30.	John Gilmore, Labor	4 95
Dec.	1.	U. S. Express Co., Expressage	1 60
"	7.	Andrus & Church, 1 M Letter Heads	4 75
"	7.	I. P. Roberts, Traveling Expenses	17 70
"	8.	L. V. R. R. Co., Freight and Cartage	1 12
"	14.	Protection Manufacturing Co., Chemicals	7 50
"	14.	Cotte & Gliemann, Palm Nut Meal	12 59
"	16.	J. Slight, Potatoes	3 30
"	16.	Tice & Lynch, Ocean Freight and Cartage	12 20
"	29.	J. Miller, Potatoes	3 95
"	29.	E. McGillivray, Dry Plates	1 80
1897:			
Jan.	1.	J. E. Slight, Potatoes	4 41
"	6.	Fuestes Pharmacy, Chemicals	3 75
"	12.	L. V. R. R. Co., Freight and Cartage	4 30
"	23.	J. H. Van Ness, Artichokes	50
"	30.	G. W. Tailby, Labor	1 72
"	30.	A. J. Briggs, Labor	3 90
Feb.	27.	A. J. Briggs, Labor	4 20
"	27.	M. Raub, Labor	3 00
Mar.	4.	George Small, Lumber	1 24
"	11.	M. F. Webster, Labor	1 00
"	13.	D. M. Osborne & Co., Casting	25
Apr.	14.	H. C. Troy, Labor	16 70
"	26.	U. S. Express Co., Expressage	45
"	27.	Treman, King & Co., Rubber Belting	1 43
"	27.	J. M. Thorburn & Co., Grass Seed	1 17
"	29.	U. S. Express Co., Expressage	70
		Amount carried forward	$490 98

		Amount brought forward	$490 98
Apr.	30.	L. C. Anderson, Labor	6 40
"	30.	John Gilmore, Labor	75
May	1.	Campbell & Wood, Brick	39 00
"	1.	Treman, King & Co., Supplies	60
"	1.	L. J. Farmer, Strawberry Plants	2 25
"	1.	L. F. Noxon, Garden Seeds	3 80
"	10.	L. V. R. R. Co., Freight and Cartage	1 36
"	24.	H. C. Troy, Labor	16 60
June	3.	Peter Henderson, Garden Seeds	5 10
"	3.	Godfrey & Gilbert, Repairs	6 72
"	7.	Horace Atwood, Labor	32 00
"	8.	L. Anderson, Labor	16 00
"	12.	W. C. Wisser, Fancy Cheese	6 68
"	15.	L. F. Noxon, Seeds	12 95
"	18.	F. Cramer, Labor	7 50
"	21.	B. F. White, Photographs	7 33
"	24.	G. R. Chamberlain, Labor	1 00
"	30.	Theodore VanAtta, Labor	37 00
		Total for Agricultural Division	$694 02

FOR HORTICULTURAL DIVISION.

1896.			
July	6.	D. Gallagher, Labor	2 85
"	6.	William Cunningham, Labor	2 85
"	17.	A. A. Terrill & Co., Repairing Roof of Barn	45 64
"	18.	Ira Grover, Hay	11 28
"	21.	W. H. Morgan, Labor	3 48
"	21.	C. T. Stephens, Seeds	1 90
"	21.	Peter Henderson, Seeds	20
"	21.	Pitcher & Manda, Seeds	15
Aug.	1.	Ira Grover, Labor	37 00
Sept.	2.	Ira Grover, Labor	37 50
"	16.	M. G. Kains, Traveling Expenses	7 79
"	16.	C. E. Hunn, Traveling Expenses	12 50
"	16.	W. Miller, Traveling Expenses	17 10
"	26.	Peter Henderson, Seeds	50
"	26.	D. M. Ferry & Co., Seeds	22
"	26.	W. W. Rawson & Co., Seeds	25
"	26.	W. A. Manda, Seeds	10
"	26.	J. C. Vaughn, Seeds	25
Oct.	1.	Ira Grover, Labor	37 50
"	3.	F. Ellis, Hay	12 53
"	19.	H. A. Dreer, Mushroom Spawn	6 50
"	19.	Hawkins & Todd, Dry Goods	16 19
"	19.	Slocum & Taber, Sundry Supplies	13 38
"	19.	C. T. Stephens, Grass Seed	1 35
"	19.	A. J. Calkins, Harness Repairs	2 20
"	19.	Fall Creek Milling Co., Feed and Bran	16 71
"	19.	White & Burdick, Chemicals	4 65
"	19.	Andrus & Church, Sundry Supplies	19 75
"	19.	J. M. Thorburn & Co., Seeds	6 00
"	21.	Burns Bros., Horse Shoeing	11 15
"	23.	Fall Creek Milling Co., Feed and Bran	7 68
		Amount carried forward	$337 15

		Amount brought forward	$337 15
Oct.	23.	C. J. Rumsey, Sundry Supplies	57 51
"	26.	J. M. Thorburn & Co., Seeds	3 00
"	27.	H. Cannell & Sons, Seeds	71
"	27.	L. Roesch, Seeds	65
Nov.	2.	Ira Grover, Labor	37 50
"	4.	L. V. R. R. Co., Freight and Cartage	1 66
"	5.	Burns Bros., Horse Shoeing	1 50
"	17.	E. & H. T. Anthony, Photographic Supplies	5 56
"	28.	W. B. Schutt, Hay	10 39
"	30.	U. S. Dept. Agr , 200 Index Cards	2 00
Dec.	2.	Ira Grover, Labor	37 50
"	7.	Dammann & Co., Seeds	33
"	10.	E. & H. T. Anthony, Chemicals	1 77
"	12.	L. V. R. R. Co., Freight and Cartage	1 47
1897.			
Jan.	9.	Rothschild Bros., Supplies	90
"	9.	Ira Grover, Labor	37 50
"	9.	J. B. Freese, Straw	10 55
"	12.	J. B. Todd, Chemicals	1 95
"	16.	J. Reidy & Co., Supplies	13 33
"	23.	Syracuse Supply Co., Steel Stamp	2 50
"	23.	Burns Bros., Horse Shoeing	2 30
"	23.	J. A Salzer & Co., Seeds	50
"	26.	J. M. Thorburn & Co., Seeds	3 98
"	26.	Eimer & Amend, Chemicals	6 03
"	26.	Pritchard & Son, Wagon Repairs	11 95
"	29.	Salem Twist, Team	200 00
Feb.	2.	Ira Grover, Labor	37 50
"	13.	George Small, Lumber	10 03
"	16.	L. V. R. R. Co., Freight and Cartage	2 14
"	18.	D. L. & W. R. R. Co., Freight and Cartage	45
"	20.	C. U. Repair Dept., Repairs	9 00
"	25.	Burns Bros., Horse Shoeing	4 70
"	25.	J. M. Thorburn & Co., Seeds	86
"	25.	Fall Creek Milling Co., Feed and Bran	7 45
"	25.	A. A. Ricksecker, Plants	1 10
"	25.	Driscoll Bros. & Co., Building Material	7 27
"	25.	J. B. Lang, Repairing Engine	1 56
"	25.	State Veterinary College, Medicine	1 10
"	26.	O. Mitchell, Oats	12 89
"	26.	E. Prestwick, Hay	27 97
Mar.	2.	U. S. Dept. Agr., 200 Index Cards	2 00
"	3.	Ira Grover, Labor	37 50
"	4.	Rubber Stamp Works, Stamp	78
"	4.	Burns Bros., Horse Shoeing	2 40
"	4.	Syracuse Pottery Co., Crockery	4 40
"	17.	Teed & Trench, Horse Blankets	5 00
"	20.	L. V. R. R. Co., Freight and Cartage	1 46
Apr.	3.	Ira Grover, Labor	37 50
"	6.	D. L. & W. R. R. Co., Freight	55
"	14.	B. Chase, Pot Labels	3 30
"	17.	R. R. Co., Freight and Cartage	1 24
"	20.	Scoville & Adams, Supplies	8 02
"	20.	U. S. Express Co., Expressage	60
		Amount carried forward	$1,018 96

		Amount brought forward	$1,018 96
May	1.	C. J. Rumsey & Co., Supplies	41 90
"	3.	Ira Grover, Labor	37 50
"	4.	J. M. Preswick, Oats	23 13
"	5.	Driscoll Bros. & Co., Cement	1 00
"	10.	U. S. Express Co., Expressage	1 20
"	10.	L. V. R. R. Co., Freight and Cartage	2 60
"	18.	U. S. Express Co., Expressage	35
June	2.	Ira Grover, Labor	37 50
"	3.	F. E. Britton, Labor	90
"	3.	C. J. Rumsey, Glass	17 40
"	21.	C. J. Rumsey, Supplies	86 60
"	23.	C. J. Rumsey, Supplies	28 66
"	23.	A. J. Calkins, Harness Repairs	2 20
"	30.	Ira Grover, Labor	37 50
"	30.	Andrus & Church, Stationery	5 75
		Total for Horticultural Division	$1,343 15

FOR CHEMICAL DIVISION.

1896.			
July	3.	J. K. Haywood, Labor	31 35
"	20.	Fuertes Pharmacy, Chemicals	66
Aug.	1.	J. K. Haywood, Labor	56 25
Sept.	3.	J. K. Haywood, Labor	54 90
Oct.	2.	Bush and Dean, Supplies	75
"	3.	J. K. Haywood, Labor	42 45
"	19.	E. B. Holcomb, Labor	4 50
"	31.	J. K. Haywood, Labor	22 05
"	31.	J. P. Troy, Towels	75
Nov.	27.	G. C. Caldwell, Traveling Expenses	23 35
Dec.	11.	Treman, King & Co., Belting	75
1897.			
Jan.	9.	Treman, King & Co., Supplies	46 35
Feb.	1.	B. S. Cushman, Labor	8 40
Mar.	24.	B. S. Cushman, Labor	6 00
June	14.	Cornell Univ. Chemical Dept., Supplies	144 45
		Total for Chemical Division	$442 96

FOR BOTANICAL DIVISION.

1896.			
July	1.	White & Burdick, Supplies	2 70
"	7.	G. E. Stechert, Publications	22 71
"	7.	Reed & Montgomery, Book Binding	1 00
"	17.	Dr. C. L. Anderson, Collection of Plants	10 00
"	27.	U. S. Express Co., Expressage	25
"	29.	C. F. Libbie & Co., Supplies	5 25
"	29.	Andrus & Church, Rubber Bands	15
"	29.	Cambridge Supply Co., Botanical Case	15 00
"	29.	Platt Drug Co., Chemicals	1 25
Aug.	10.	National Express Co., Expressage	35
Sept.	14.	U. S. Express Co., Expressage	25
Oct.	2.	Richards & Co., Chemicals	7 10
		Amount carried forward,	$66 01

		Amount brought forward	$66 01
Oct.	2.	G. E. Stechert, Publications	1 74
"	2.	Andrus & Church, Stationery	6 25
"	2.	White & Burdick, Chemicals	5 18
"	2.	Bush & Dean, Muslin	1 15
"	2.	Bausch & Lomb, Microscopic Supplies	7 05
"	2.	Eimer & Amend, Microscopic Supplies	10 00
"	6.	National Express Co., Expressage	35
Nov.	11.	U. S. Express Co., Expressage	80
"	17.	Rochester Optical Co., Photographic Supplies	29 88
"	17.	J. Carbutt, Microscopic Supplies	4 25
"	17.	Bausch & Lomb, Camera	3 00
"	18.	Bertha Stoneman, Labor	9 40
Dec.	7.	Dr. C. L. Anderson, Collection of Plants	10 00
"	7	E. Steigler & Co., Models	45 53
"	7.	Eimer & Amend, Chemicals	4 60
"	10.	Rothschild Bros., Fruit Jars	5 81
"	10.	Bausch & Lomb, Chemicals	1 69
"	23.	Enz & Miller, Paper	6 13
"	23.	Bausch & Lomb, Botanical Supplies	25 50
"	23.	White & Burdick, Chemicals	7 90
"	23.	E. McGillivray, Photographic Supplies	32 32
"	23.	Rochester Optical Co., Photographic Supplies	10 20
"	23.	J. B. McAllister, Meat for Experiment Purposes	6 05
1897.			
Jan.	12.	J. Carbutt, Photographic Supplies	7 23
"	12.	Bausch & Lomb, Mirror	40
"	12.	Bausch & Lomb, Filter	3 00
Feb.	12.	U. S. Express Co., Expressage	70
"	20.	E. Steigert & Co., Publications	6 37
"	20.	G. E. Stechert, Publications	92
"	20.	G. F. Atkinson, Traveling Expenses	17 75
"	25.	G. E. Stechert, Publications	10 60
"	25.	E. A. Allen, Publications	20 09
"	27.	B. Fink, Lichens	1 16
Mar.	6.	Bool Co., Furniture	15 50
"	17.	White & Burdick, Chemicals	7 84
"	29.	Bausch & Lomb, Microscopic Supplies	1 53
Apr.	20.	U. S. Express Co., Expressage	25
"	27.	Eimer & Amend, Microscope and Fixtures	109 52
May	7.	B. Stoneman, Labor	9 00
June	4.	B. Stoneman, Labor	4 75
"	15.	White & Burdick, Chemicals	8 09
"	15.	J. M. Thorburn & Co., Seeds	2 85
"	15.	Cambridge Supply Co., Publications	6 00
"	19.	G. E. Stechert, Publications	3 54
"	19.	B. F. White, Photographic Supplies	50 75
"	19.	Bool Co., Furniture	75 48
		Total for Botanical Division	$664 11

FOR ENTOMOLOGIGAL DIVISION.

1896.			
July	6.	Wm. Menzel & Co., Chemicals	2 91
"	11.	M. V. Slingerland, Traveling Expenses	3 30
		Amount carried forward	$6 21

		Amount brought forward	$6 21
July	13.	E. McGillivray, Photographic Supplies	6 79
"	13.	A. B. Kennedy, Supplies	1 25
"	13.	J. B. Todd, Chemicals	1 63
"	24.	Treman, King & Co., Lime	95
"	24.	Andrus & Church, Stationery	50
"	29.	Treman, King & Co , Supplies	4 93
"	29.	Jamieson & McKinney, Rubber Hose and Fixtures	4 20
"	29.	Treman, King & Co., Supplies	1 55
"	29.	A. B. Brooks, Chemicals	6 98
"	31.	P. Henderson, Seeds	77
"	31.	W. A. Slingerland, Labor	24 00
Aug.	4.	Western Union Telegraph Co., Telegrams	6 42
"	20.	Andrus & Church, Stationery	1 20
"	20.	Bool Co., Curtains	1 20
"	20.	E. McGillivray, Photographic Supplies	2 52
"	31.	White & Burdick, Chemicals	64
"	31.	W. A. Slingerland, Labor	24 00
Sept.	8.	Andrus & Church, Stationery	6 00
"	8.	Treman, King & Co., Ash Can	2 15
"	9.	M. V. Slingerland, Express	30
"	14.	Bausch & Lomb, Repairs	29
"	28.	National Express Co., Expressage	25
Oct.	1.	W. A. Slingerland, Labor	20 85
"	3.	U. S. Express Co., Expressage	50
"	6.	G. Cramer, Photographic Supplies	8 68
"	8.	U. S. Express Co., Expressage	2 15
"	12.	E. McGillivray, Photographic Supplies	2 70
"	17.	National Express Co., Expressage	25
"	29.	Bausch & Lomb, Photographic Supplies	56
"	31.	National Express Co., Express	25
"	31.	W. A. Slingerland, Labor	10 00
Nov.	18.	Rothschild Bros., Lamp	1 97
"	18.	Peter Henderson, Plants	4 70
"	21.	U. S. Express Co., Expressage	90
Dec.	1.	W. A. Slingerland, Labor	11 40
"	7.	D. B. Stewart & Co., Oil	4 32
"	9.	Taylor & Preswick, Stationery	1 00
"	10.	C. U. Dept. of Repairs	89
"	23.	Treman, King & Co., Supplies	2 23
"	23.	C. U. Dept. of Repairs, Repairs	5 33
"	23.	E. McGillivray, Photographic Supplies	3 45
"	31.	W. A. Slingerland, Labor	14 25
1897.			
Jan.	6	Andrus & Church, Stationery	1 55
"	6.	E. McGillivray, Photographic Supplies	1 75
"	12.	Andrus & Church, Stationery	50
"	13.	M. V. Slingerland, Labor	2 70
"	26.	W. A. Slingerland, Labor	14 55
Feb.	11.	L. Lauren, Labor	11 25
"	25.	M. V. Slingerland, Express	1 50
"	25.	Taylor & Preswick, Typewriter Ribbon	75
"	27.	W. A. Slingerland, Labor	16 50
Mar.	6.	Andrus & Church, Stationery	90
		Amount carried forward	$253 06

		Amount brought forward	$253 06
Mar.	23.	L. V. R. R. Co., Freight and Cartage	85
"	29.	A. B. Little, Typewriter Ribbon	1 50
"	31.	W. A. Slingerland, Labor	14 25
pr.	10.	U. S. Express Co., Expressage	1 25
"	28.	L. V. R. R. Co., Freight and Cartage	50
May	1.	W. A. Slingerland, Labor	15 70
"	1.	W. F. Falconer Mfg. Co., Supplies	15 00
"	1.	Andrus & Church, Supplies	7 60
"	15.	Mary Rogers, Labor	63 00
"	18.	U. S. Express Co., Expressage	80
"	22.	Andrus & Church, Stationery	75
June	1.	W. A. Slingerland, Labor	14 55
"	2.	Library Bureau, Supplies	2 50
"	3.	Andrus & Church, Stationery	2 40
"	3.	Treman, King & Co., Torch	45
"	7.	Library Bureau, Supplies	2 80
"	7.	Hawkins & Todd, Pins	2 50
"	7.	White & Burdick, Chemicals	3 26
"	7.	Bausch & Lomb, Supplies	9 49
"	9.	Andrus & Church, Stationery	3 00
"	12.	Lucy Torrance, Labor	2 20
"	25.	C. U. Dept. of Repairs, Repairs	23 70
"	24.	Whitehall, Tatum & Co., Chemicals	9 45
		Total for Entomological Division	$450 56

FOR DAIRY BACTERIOLOGICAL DIVISION.

1897.			
June	2.	William Boekel & Co., Incubator	95 00
"	5.	L. V. R. R. Co., Freight and Cartage	1 73
"	30.	Edward Pennock, Microscope and Fixtures	298 88
		Total for Bacteriological Division	$395 61

FOR VETERINARY SCIENCE DIVISION.

1897.			
May	6.	C. E. Bruce, Cow for Experimental Purposes	30 00
"	12.	J. C. Hart, Cow for Experimental Purposes	55 00
			$85 00

SUMMARY.

The Agricultural Experiment Station of Cornell University, in account with the United States appropriation.

1897.	Dr.		
To Receipts from Treasurer of the United States as per appropriation for the year ending June 30, 1897, under Act of Congress approved March 2, 1887 . . .			$13,500 00
	Cr.		
June 30.	By Salaries	$8,043 75	
	Printing	351 75	
	Office Expenses	1,029 09	
	EQUIPMENT, LABOR AND CURRENT EXPENSES.		
	Agriculture	694 02	
	Horticulture	1,343 15	
	Chemistry	442 96	
	Botany	664 11	
	Entomology	450 56	
	Dairy Bacteriology	395 61	
	Veterinary Science	85 00	
			$13,500 00
	RECEIPTS FOR PRODUCE SOLD.		
	Balance from 1895–6	850 29	
	Agricultural Division	34 00	
	Horticultural Division	89 54	
	Office	35 75	
			$ 1,009 58
	Printing.	427 34	
	Office	16	
	Balance to 1897–8	582 08	
			$ 1,009 58

GENERAL INDEX.

INDEX OF CUTS.

APPENDIX III.

Teacher's Leaflets on Nature-Study.

No. 1. How a Squash Plant gets out of the Seed.

No. 2. How a Candle Burns.

No. 3. Four Apple Twigs.

No. 4. A Children's Garden.

No. 5. Some Tent Makers.

No. 6. What is Nature-Study ?

No. 7. Hints on Making Collections of Insects.

THIRD EDITION.

No. 1.

DEC. 1, 1896.

TEACHER'S LEAFLETS

FOR USE IN THE PUBLIC SCHOOLS.

PREPARED BY

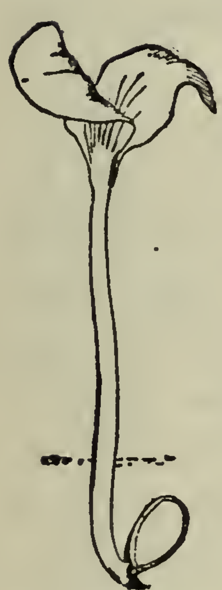
THE COLLEGE OF AGRICULTURE,
CORNELL UNIVERSITY,

ITHACA, N. Y.

Issued under Chapter 128
of the Laws of 1897.

How a Squash Plant Gets Out of the Seed.

BY L. H. BAILEY.



1. *Squash plant a week old.*

If one were to plant seeds of a Hubbard or Boston Marrow squash in loose, warm earth in a pan or box, and were then to leave the parcel for a week or ten days, he would find, upon his return, a colony of plants like that shown in Fig. 1. If he had not planted the seeds himself or had not seen such plants before, he would not believe that these curious plants would ever grow into squash vines, so different are they from the vines which we know in the garden. This, itself, is a most curious fact,—this wonderful difference between the first and the later stages of all plants, and it is only because we know it so well that we do not wonder at it.

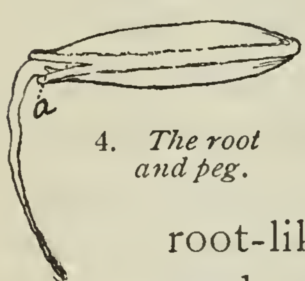
NOTE.—These leaflets are intended for the teacher, not for the scholars. It is their purpose to suggest the method which a teacher may pursue in instructing children at odd times in nature-study. The teacher should show the children the objects themselves,--should plant the seeds, raise the plants, collect the insects, etc. ; or, better, he should interest the children to collect the objects. Advanced pupils, however, may be given the leaflets and asked to perform the experiments or make the observations which are suggested. The scholars themselves should be taught to do the work and to arrive at independent conclusions. Teachers who desire to inform themselves more fully upon the motives of this nature-study teaching, should write for a copy of Bulletin 122, of the Cornell Experiment Station, Ithaca, N. Y.

It may happen, however,—as it did in a pan of seed which I sowed a few days ago—that one or two of the plants may look like that shown in Fig. 2. Here the seed seems to have come up on top of the plant, and one is reminded of the curious way in which beans come up on the stalk of the young plant. If we were to study the matter, however,—as we may do at a future time—we should find a great difference in the ways in which the squashes and the beans raise their seeds out of the ground. It is not our purpose to compare the squash and the bean at this time, but we are curious to know why one of these squash plants brings its seed up out of the ground whilst all the others do not. In order to find out why it is, we must ask the plant, and this asking is what we call an experiment.

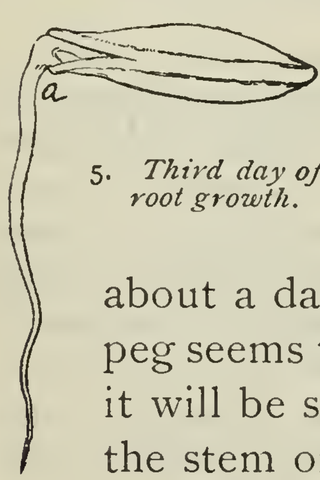
2. *Squash plant which has brought the seed-coats out of the ground.*

3. *Germination just beginning.*

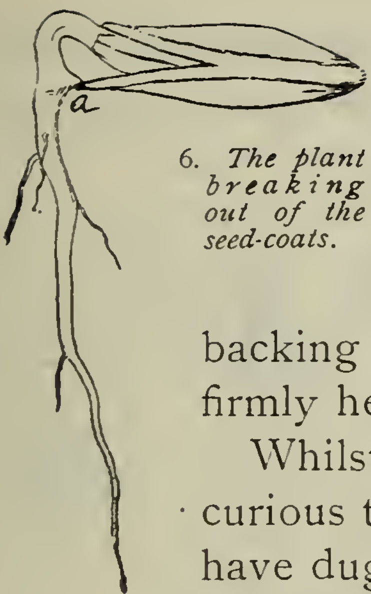
We may first pull up the two plants. The first one (Fig. 1) will be seen to have the seed-coats still attached to the very lowest part of the stalk below the soil, but the other plant has no seed at that point. We will now plant more seeds, a dozen or more of them, so that we shall have enough to examine two or three times a day for several days. A day or two after the seeds are planted, we shall find a little point or root-like portion breaking out of the sharp end of the seed, as shown in Fig. 3. A day later this root portion has grown to be as long as the seed itself (Fig. 4), and it has turned directly downwards into the soil. But there is another most curious thing about this germinating seed. Just where the root is breaking out of the seed (shown at *a* in Fig. 4), there is a little peg or projection. In Fig. 5, about a day later, the root has grown still longer, and this peg seems to be forcing the seed apart. In Fig. 6, however, it will be seen that the seed is really being forced apart by the stem or the stalk above the peg, for this stem is now growing longer. The lower lobe of the seed has attached



4. *The root and peg.*



5. *Third day of root growth.*

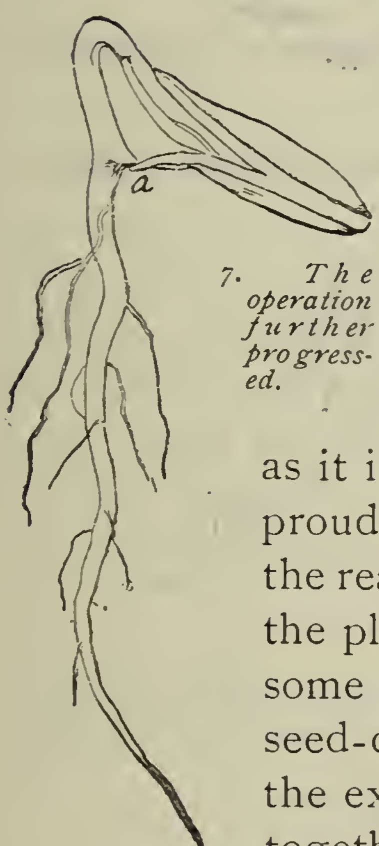


6. *The plant breaking out of the seed-coats.*

to the peg (seen at *a*, Fig. 6), and the seed-leaves are trying to back out of the seed. Fig. 7 shows the seed still a day later. The root has now produced many branches and has thoroughly established itself in the soil. The top is also growing rapidly and is still backing out of the seed, and the seed-coats are still firmly held by the obstinate peg.

8. *The plant just coming up.*

Whilst we have been seeing all these curious things in the seeds which we have dug up, the plantlets which we have not disturbed have been coming through the soil.

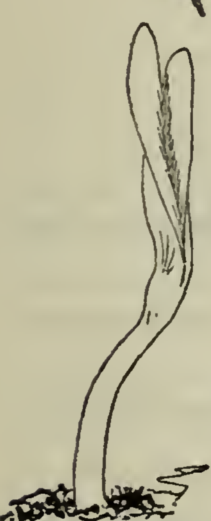


7. *The operation further progressed.*

If we were to see the plant in Fig. 7, as it was "coming up," it would look like Fig. 8. It is tugging away trying to get its head out of the bonnet which is pegged down underneath the soil, and it has "got its back up" in the operation. In Fig. 9, it has escaped from its trap and it is laughing and growing in delight. It must now straighten itself up, as it is doing in Fig. 10, and it is soon standing proud and straight, as in Fig. 1. We now see that the reason why the seed came up on the plant in Fig. 2, is because in some way the peg did not hold the seed-coats down (see Fig. 13), and the expanding leaves are pinched together, and they must get themselves loose as best they can.

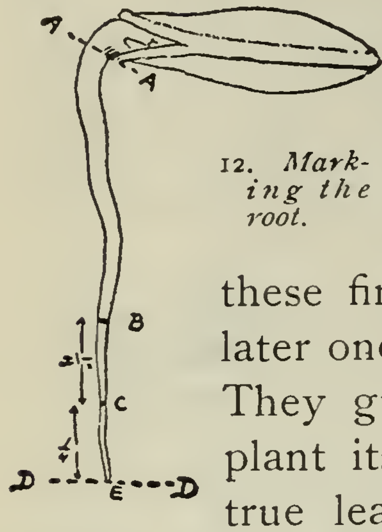
9. *The plant liberated from the seed-coats.*

There is another thing about this curious squash plant which we must not fail to notice, and this is the fact that these first two leaves of the plantlet came out of the seed and did not grow out of the plant itself. We must notice, too, that these leaves are much smaller when they are first drawn out of the seed than they are when the plantlet has straightened itself up. That is, these leaves increase very much in size after they reach the light

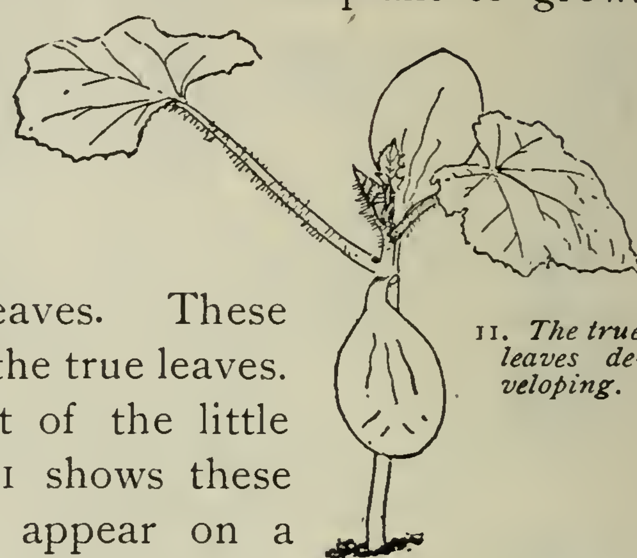


10. *The plant straightening up.*

and air. The roots of the plantlet are now established in the soil and are taking in food which enables the plant to grow.



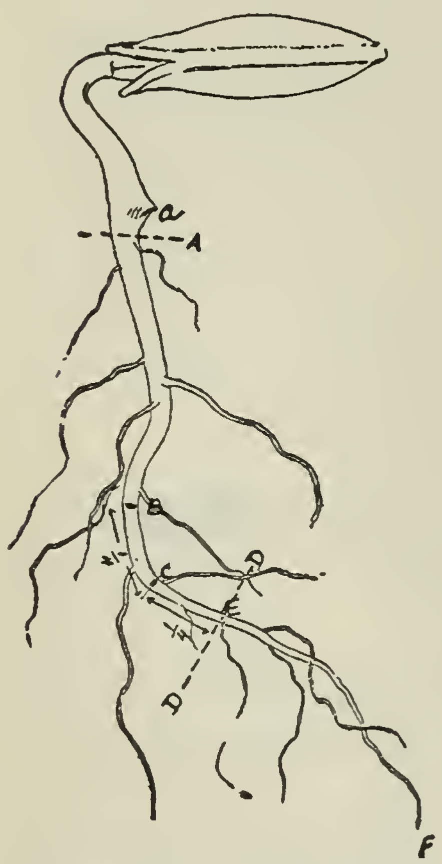
12. *Marking the root.*



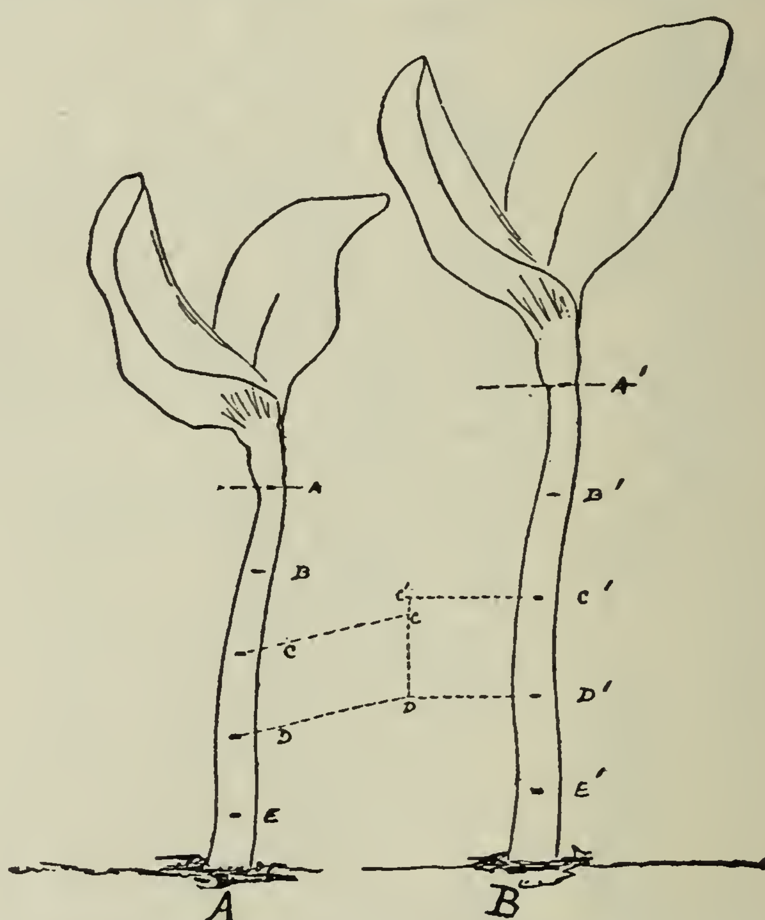
11. *The true leaves developing.*

The next leaves which appear will be very different from these first or seed leaves. These later ones are called the true leaves. They grow right out of the little plant itself. Fig. 11 shows these true leaves as they appear on a young Crookneck squash plant, and the plant now begins to look much like a squash vine.

We are now curious to know how the stem grows when it



13. *The root grows in the end portions.*



14. *The marking of the stem, and the spreading apart of the marks.*

backs out of the seeds and pulls the little seed leaves with it, and how the root grows downwards into the soil. Now let us pull up another seed when it has sent a single root about two

inches deep into the earth. We will wash it very carefully and lay it upon a piece of paper. Then we will lay a ruler alongside of it, and make an ink mark one-quarter of an inch from the tip, and two or three other marks at equal distances above (Fig. 12).* We will now carefully replant the seed. Two days later we will dig it up, when we shall most likely find a condition something like that in Fig. 13. It will be seen that the marks E, C, B, are practically the same distance apart as before and they are also the same distance from the peg AA. The point of the root is no longer at DD, however, but has grown on to F. The root, therefore, has grown almost wholly in the end portion.

Now let us make a similar experiment with the stem or stalk. We will mark a young stem, as at A in Fig. 14; but the next day we shall find that these marks are farther apart than when we made them (B, Fig. 14). The marks have all raised themselves above the ground as the plant has grown. The stem, therefore, has grown between the joints rather than from the tip. The stem usually grows most rapidly, at any given time, at the upper or younger portion of the joint (or internode); and the joint soon reaches the limit of its growth and becomes stationary, and a new one grows out above it.

Natural science consists in two things,—seeing what you look at, and drawing proper conclusions from what you see.

---

* NOTE.—Common ink will not answer for this purpose because it "runs" when the root is wet, but indelible ink, used for marking linen or for drawing, should be used. It should also be said that the root of the common pumpkin, and of the summer bush squashes, is too fibrous and branchy for this test. It should be stated, also, that the root does not grow at its very tip, but chiefly in a narrow zone just back of the tip; but the determination of this point is rather too difficult for the beginner, and, moreover, it is foreign to the purpose of this tract.

To the Teacher:

This is the first of a proposed series of leaflets designed to suggest methods of presenting nature-study upon common-place subjects. This is a new field of effort for the College of Agriculture, and we therefore look upon the methods as largely experimental. We are endeavoring to determine the best way of interesting children in country life. You can give us many suggestions, and we should like a free expression of your opinions and experiences. It should be borne in mind that the object of these lessons is not to impart direct and specific information, but to train the child in the powers of seeing and inquiring. The teacher should keep the attention of the pupil closely fixed upon the germinating seed (when the subject of this leaflet is under review), asking him to describe everything which he sees. Require that the pupil sees all that is specified in this leaflet, and endeavor to lead him on to see things which are not here described. Once the inquiry is started, you will no doubt be able to conduct other similar experiments from time to time. If questions come up which you cannot answer, write them to us and we may be able to help you.

We suggest that you ask your pupils to write short compositions upon these lessons and to make sketches of the observations, and that you send us some of these from time to time, in order that we may learn how the experiment is working. We do not care for the best essays alone, but simply the average. The suggestions which we obtain from teachers will aid us greatly in the preparation of future leaflets.

THIRD EDITION.

No. 2.

MAY 21, 1897.

TEACHER'S LEAFLETS

FOR USE IN THE PUBLIC SCHOOLS.

PREPARED BY

THE COLLEGE OF AGRICULTURE, CORNELL UNIVERSITY,

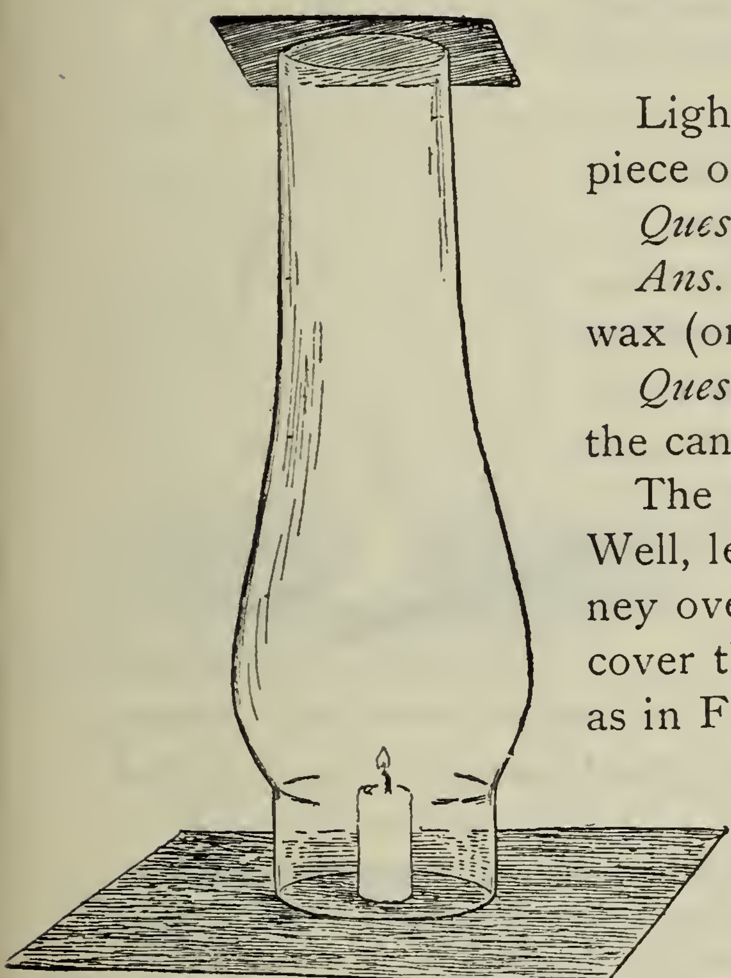
ITHACA, N. Y.

Issued under Chapter 128
of the Laws of 1897.

How a Candle Burns.

BY GEORGE W. CAVANAUGH.

I. OXYGEN.



15. *The beginning of the experiment.*

Light the candle and place it upon a piece of blotting paper.

Ques. What do you see burning?

Ans. The candle; or the wick and wax (or tallow).

Ques. Is anything burning besides the candle?

The answer will probably be "No." Well, let us see. Place the lamp chimney over the lighted candle, and partly cover the top by a piece of stiff paper, as in Fig. 15. Ask the pupils to observe and describe how the flame goes out; i. e., that it is gradually extinguished and does not go out instantly.

Ques. Why did the flame go out?

The probable answer will be, "Because there was no air." (If there was no air within the chimney, some could have entered

NOTE TO THE TEACHER.—The materials needed for this exercise are a piece of candle about two inches long, a lamp chimney (one with a plain top is best), a

at the top.) Place a couple of pencils beside the relighted candle and on them the chimney, as in Fig. 16.

Ques. What is the difference between the way in which the candle burns now and before the chimney was placed over it?

Ans. It flickers, or dances about more.

Ques. What makes boys and girls feel like dancing about when they go out from a warm school room?

Ans. The fresh air.

Ques. What makes the flame dance or flicker when the chimney is raised by the pencils?

Ans. Because it gets fresh air under the chimney.

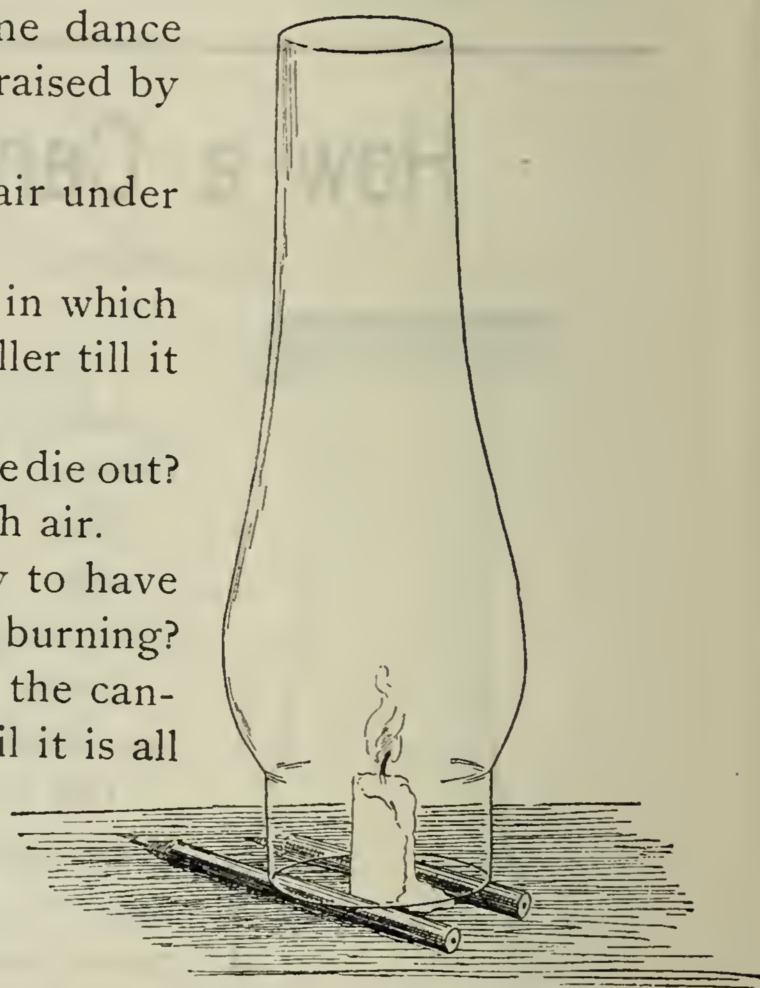
Repeat the first experiment, in which the flame grows gradually smaller till it is extinguished.

Ques. Why now does the flame die out?

Ans. Because it had no fresh air.

Ques. Is it really necessary to have fresh air in order to keep a flame burning?

Ans. Yes; since otherwise the candle would continue to burn until it is all used up.



16. *Supplying air underneath the chimney.*

To prove this further, let the candle be relighted. Place the chimney over it, now having the top completely closed by a piece of paper. Have ready a lighted splinter or match, and

---

piece of white crockery or window glass, a piece of fine wire about six inches long, a bit of quicklime about half the size of an egg, and some matches. All of these, with the possible exception of the quicklime, can be obtained in any household. If you perform the experiment requiring the lime, be sure that you start with a fresh piece of quick or stone lime, which can be had of any lime or cement dealer. During the performance of the following simple experiments, ask your pupils to describe to you what they see you do at each step. The questions inserted in the text are offered merely as suggestions in the developing of the desired ideas. The answers, which are intended only for the teacher, are those which it is desired shall be given by the pupils.

just as soon as the candle is extinguished remove the paper from the chimney-top and thrust in the lighted splinter.

Ques. Why does the light on the splinter go out?

Ans. Because there is no fresh air inside the chimney.

Ques. What became of the freshness that was in the air?

Ans. It was destroyed by the burning candle.

Evidently there is some decided difference between fresh air and air from which the freshness has been burned, since a flame can continue to burn only in air that has the quality known as freshness. This quality in fresh air is due to a gas which has the name of oxygen, and which is represented by the letter O.

Ques. Why was the splinter put out instantly while the candle flame died out gradually?

Ans. When the splinter was thrust in, the air had no freshness or oxygen at all, while when the candle was placed under the chimney it had whatever oxygen was originally in the air within the chimney.

Endeavor to have this point clearly understood: that the candle did not go out as long as the air had any oxygen and that the splinter was extinguished immediately because there was no oxygen left. Relight the candle. Our second question may now be repeated:

Ques. Is anything else burning besides the candle?

Ans. Yes; the oxygen of the air.

When the subject of the necessity of fresh air and consequently of oxygen for the burning of the candle seems to be understood, the following questions, together with any others which suggest themselves, may be asked.

What is the reason that draughts are opened in stoves?

Why is the bottom of a "burner" on a lamp always full of holes?

II. Carbon.

Let us now observe the blackened end of a burned match or splinter. This black substance is usually known by the name of charcoal and if handled will blacken the fingers. Try this. The same substance is found on the bottoms of kettles which have been used over a wood fire, only it is a fine powder.

Let us see what was burning when the candle was lighted, besides the oxygen in the air. Relight the candle and hold the porcelain or glass about an inch above the bright part of the flame.

Ques. What happens to it there ?

Next lower it directly into the flame. (Fig. 17.)

Ques. What is the black stuff that gets onto the glass ?

Look closely and see whether it is not deposited here also as a fine powder.

17. *The carbon or soot on the glass.*

Ques. Will this deposit from the candle blacken the fingers ?

Instead of using the name charcoal for this black substance, let us call it carbon (represented by C), the better name, because there are several kinds of carbon, and charcoal is only that kind which is rather light and easily blackens the hands. Some other kinds are the diamond, coal and the black substance in lead pencils. This last kind is called graphite.. These are all much harder than charcoal.

The carbon from the candle flame came mostly from the wax or tallow ; only a very small portion came from the wick.

It cannot be seen in the tallow, neither can it be seen in unburned wood, and yet it can be found when the wood is partly burned. The condition in which the carbon exists in the tallow or wood may be explained in a later lesson. At present it suffices that it is there.

Why, now, is the glass blackened when held in the flame and not when held just directly above it ? It is because the carbon from the candle has not been completely burned at the middle of the flame ; but it is burned beyond the bright part of the flame. When the glass is held in the flame, the carbon that is not yet completely burned is deposited on it, because it is cooler than that in the surrounding flame.

A fine deposit of carbon can be had from any of the luminous parts of the flame ; and it is these thousands of little particles of carbon, getting white hot, which glow like coals in the stove and

make the light. Just as soon as they are completely burned, there is no more light, the same as coals cease to glow when burned to ashes.

III. Carbon dioxid.

Let us now enquire what becomes of the carbon that we find in the bright part of the flame and of the oxygen that was in the air in the lamp chimney. When the candle was extinguished within the chimney there was no oxygen left, as shown by the lighted splinter which was put out immediately. Neither could any of the particles of carbon be found except on the wick. Yet they both still exist within the chimney but in an entirely different condition than before. While the candle was burning the little particles of carbon that we find ascending in the flame are joining with the oxygen of the air and making an entirely new substance. This new substance is a gas like oxygen and can not be seen in the air.

Ques. Of what two substances is this new substance made?

Ans. Carbon and Oxygen.

What shall we call this substance? Since it is made of carbon and oxygen it ought, if possible, to have a name that will show its composition. Its name is carbon dioxid. The words carbon and oxid show of what it is made and the prefix *di*, which means two, shows that it contains twice as much oxygen as carbon. This is represented by the formula CO_2.

Place the bit of quicklime in about half a glass of water on the day previous to the experiment. When ready for use there will be a white sediment at the bottom and a thin white scum on the top of the clear lime water. Call the attention of the pupils to this white scum as a question about it will follow. Make a loop in the end of the piece of wire by turning it around the point of a lead pencil. Remove the scum from the lime water with a piece of paper and insert the loop into the clear water. When withdrawn, the loop ought to hold a film of clear water. Pass the wire through a piece of cardboard or stiff paper, and arrange as shown in Fig. 18.

Place the chimney over the lighted candle. Lower the loop into the chimney and cover the top of the chimney with the

paper. Withdraw the wire a couple of minutes after the candle goes out. Note the cloudy appearance of the film of water on the wire. The cloudiness was caused by the carbon dioxid formed while the candle was burning.

Omitting the candle, hang the freshly wetted wire in the empty chimney. Let the film of lime water remain within the chimney for the same length of time as when the candle was used. It does not become cloudy now. The cloudiness in clear lime water is a test or indication that carbon dioxid is present.

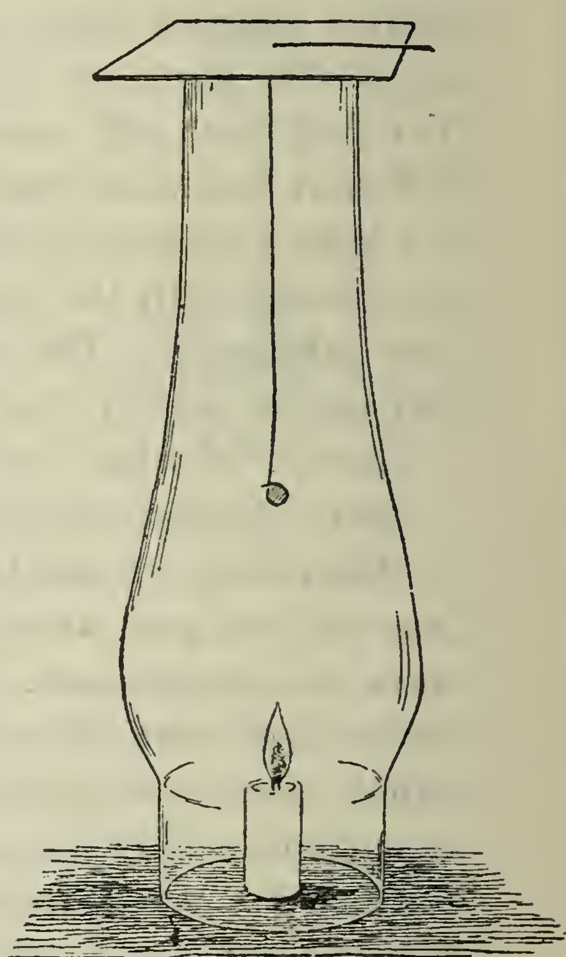
Ques. What caused the white scum on the lime water which stood over night?

Ans. Some CO_2 in the air.

Ques. How does the CO_2 get into the air?

Ans. It is formed whenever wood, coal, oil or gas is burned.

The amount of CO_2 in ordinary air is very small, being only three parts in ten thousand. If the lime water in the loop be left long enough in the air it will become cloudy. The reason it clouds so quickly when the candle is being burned is that a large amount of CO_2 is formed. Besides being made by real flames, CO_2 is formed every time we breathe out air. Renew the film of water in the loop and breathe against it gently for two or three minutes.



18. *The test with the film of lime water.*

The presence of CO_2 in the breath may be shown better by pouring off some of the clear lime water into a clean glass and blowing into it through a straw.

An interesting question to end the lesson with is: Why does water put out a fire? The answer is, not alone because it wets, but because it cools the carbon, which must be hot in order to unite with the oxygen, and prevents the oxygen of the air from getting as near the carbon as before.

To the Teacher:

This is the second of a proposed series of leaflets designed to suggest methods of presenting nature study upon common-place subjects. This is a new field of effort for the College of Agriculture, and we therefore look upon the methods as largely experimental. We are endeavoring to determine the best way of interesting children in country life. You can give us many suggestions, and we should like a free expression of your opinions and experiences. It should be borne in mind that the object of these lessons is not to impart direct and specific information, but to train the child in the powers of seeing and inquiring. The teacher should keep the attention of the pupil closely fixed upon the experiments, asking him to describe everything which he sees. Require that the pupil sees all that is specified in this leaflet, and endeavor to lead him on to see things which are not here described. Once the inquiry is started, you will no doubt be able to conduct other similar experiments from time to time. If questions come up which you cannot answer, write them to us and we may be able to help you.

We suggest that you ask your pupils to write short compositions upon these lessons and to make sketches of the observations, and that you send us some of these from time to time in order that we may learn how the experiment is working. We do not care for the best essays alone, but simply the average. The suggestions which we obtain from teachers will aid us greatly in the preparation of future leaflets. We should particularly appreciate suggestions as to the most useful subjects to be taken up in these tracts.

Teacher's Leaflets on Nature-Study.

NO. 3.

TEACHER'S LEAFLETS

FOR USE IN THE PUBLIC SCHOOLS.

FOURTH ISSUE.

No. 3.

JUNE 1, 1897.

PREPARED BY

THE COLLEGE OF AGRICULTURE,
CORNELL UNIVERSITY,

ITHACA, N. Y.

Issued under Chapter 128
of the Laws of 1897.

I. P. ROBERTS, DIRECTOR.

Four Apple Twigs.

BY L. H. BAILEY.

The other day, as I walked through an apple orchard for the first time since the long winter had set in, I was struck by the many different shapes and sizes of the limbs as I saw them against the blue-gray of the February sky. I cut four of them in passing, and as I walked back to the house I wondered why the twigs were all so different; and I found myself guessing whether there would be any apples next summer.

Now, I have had pictures made of these four little apple limbs. Let us look them over and see if they have any story to tell of how they grew and what they have set out to do.

I.

One of these twigs (Fig. 19) was taken from a strong young tree which, I remember, bore its first good crop of apples last year. This simple twig is plainly of two years' growth, for the "ring" between the old and new wood is seen at B. That is, the main stem from the base up to B grew in 1895, and the part from B to the tip grew in 1896. But the buds upon these two parts look very unlike. Let us see what these differences mean.

We must now picture to ourselves how this shoot from B to 10 looked last summer whilst it was growing. The shoot bore leaves. Where? There was one just below each bud; or, to be more exact, one bud developed just above each leaf. These

buds did not put out leaves. They simply grew to their present size and then stopped.

What are these buds of the tip shoot proposing to do in 1897? We can answer this question by going back just one year and seeing what the buds on the lower (or older) part of the shoot did in 1896. Upon that part (below B) the buds seem to have increased in size. Therefore, they must have grown last year. There were no leaves borne below these buds in 1896, but a cluster of leaves came out of each little bud in the spring. As these leaves expanded, and grew, the little bud grew on; that is, each bud grew into a tiny branch, and when fall came each of these branches had a bud on its end to continue the growth in the year to come. What we took to be simple buds at 2, 3, 4, 5, 6 are, therefore, little branches.

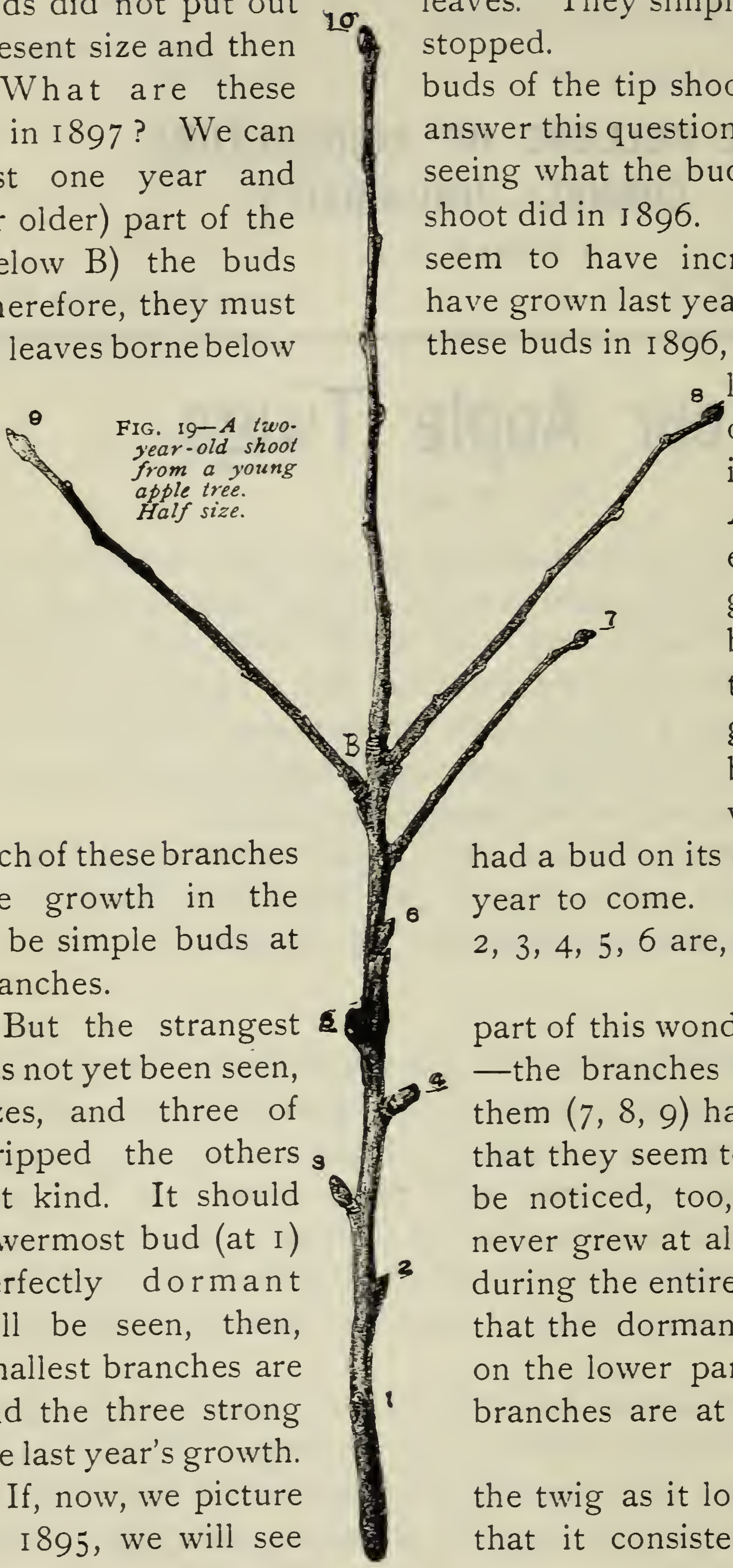


FIG. 19—*A two-year-old shoot from a young apple tree. Half size.*

But the strangest part of this wonderful little twig has not yet been seen,—the branches are of different sizes, and three of them (7, 8, 9) have so far outstripped the others that they seem to be of a different kind. It should be noticed, too, that the very lowermost bud (at 1) never grew at all, but remained perfectly dormant during the entire year 1896. It will be seen, then, that the dormant bud and the smallest branches are on the lower part of the shoot, and the three strong branches are at the very tip of the last year's growth.

If, now, we picture the twig as it looked in the fall of 1895, we will see that it consisted of a single

shoot, terminating at B. It had a large terminal bud (like those at 7, 8, 9, 10), and this bud pushed on into a branch in 1896, and three other buds near the tip did the same thing.

Why did some of these branches grow to be larger than others? "Simply because they were upon the strongest part of the shoot, or that part where the greatest growth naturally takes place," some one will answer. But this really does not answer the question, for we want to know why this portion of the shoot is strongest. The real reason is because there is more sunlight and more room on this outward or upward end. In 1897,—if this shoot had been spared—each of these four largest twigs (7, 8, 9, 10) would have done the same thing as the parent twig did in 1896: each would have pushed on from its end, and one or two or three other strong branches would probably have started from the wrong side buds near the tips, the very lowest buds would, no doubt, have remained perfectly inactive or dormant for lack of opportunity, and the intermediate buds would have made short branches like 2, 3, 4, 5, 6. In other words, the tree always tries to grow onward from its tips, and these tip shoots eventually become strong branches, unless some of them die in the struggle for existence. What, now, becomes of the little branches lower down?

II.

From another apple tree I took the twig shown in Fig. 20. We see at once that it is very unlike the other one. It seems to be two years old, one year's growth extending from the base up to 7, and the last year's growth extending from 7 to 8; but we shall see upon looking closer that this is not so. The short branchlets at 3, 4, 5, 7 are very different from those in Fig. 19. They seem to be broken off. The fact is that

Fig. 20.—*A three-year-old shoot and the fruit-spurs. Half size.*

the broken ends shown where the apples were borne in 1896. The branchlets that bore them, therefore, must have grown in 1895, and the main branch, from 1 to 7, grew in 1894. It is plain, from the looks of the buds, that the shoot from 7 to 8, grew last year, 1896.

Starting from the base, then, we have the main twig growing in 1894; the small side branches growing in 1895; these little branches bearing apples in 1896, and the terminal shoot also growing in 1896. Why was there no terminal shoot growing in 1895? Simply because its tip developed a fruit-bud (at 7) and therefore could not send out a branch; for there are two kinds of buds,—the small pointed leaf-bud and the thick blunt fruit-bud. If the branchlets 3, 4, 5, 7, are two years old, the dormant buds—1, 2—must be the same age. That is, for two long years these little buds have been waiting for some bug to eat off the buds and leaves above, or some accident to break the shoot beyond them, so that they might have a chance to grow; but they have waited in vain.

We have now found, therefore, that the little side shoots upon apple twigs become fruit-branches or fruit-spurs, whilst the more ambitious branches above them are making a great display of stem and leaves.

But will these fruit-spurs bear fruit again in 1897? No. The bearing of an apple is hard work, and these spurs did not have enough vitality left to make fruit-buds for the next year; but they must perpetuate themselves, so they have sent out small side buds which will bear a cluster of leaves and grow into another little spur in 1897, and in that year these new spurs will make fruit-buds for bearing in 1898. The side bud is plainly seen on spur 5, also on spur 4, whilst spur 7 has sown a seed, so to speak, in the bud at 6. It is therefore plain why the tree bears every other year.

III.

There was one tree in the orchard from which the farmer had not picked his apples. Perhaps the apples were not worth picking. At any rate, the dried apples, shriveled and brown, are

still hanging on the twigs, and even the birds do not seem to care for them. I broke off one of these twigs (Fig. 21). Let us see how many apples this curious twig has borne. We can tell by the square-cut scars. An apple was once borne at 1, another at 2, another at 4, another at 5, another at 6, and another at 7,—and at 7 there will be a scar when the apple falls. Six apples this modest shoot has borne! And I wonder how many of them got ripe, or how many were taken by the worms, or how many were eaten by the little boys and girls on their way to school!

A curious thing happened when the fruit was growing at 2. Two side buds started out, instead of one, and both of them grew the next year. But one of the little branchlets fell sick and died, or a bug nipped off its end, or it starved to death; and the grave is still marked by the little stick standing up at 3. The other branchlet thrived, and eventually bore apples at 4, 5, 6 and 7.

I have said that these fruit-spurs bear only every other year; then, if this branch has borne six apples, it must be twelve

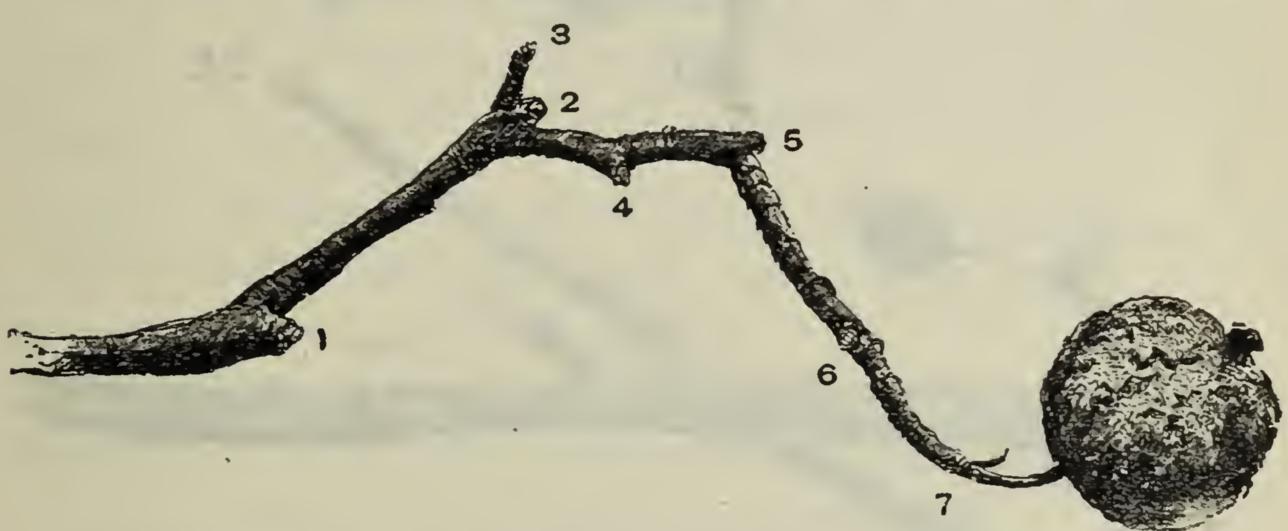


FIG. 21.—*A fruit-spur which has borne six apples. Half size.*

years old. The truth is that it is about twenty years old, for some years it failed to bear; but the age cannot be traced out in the picture, although any little boy or girl with bright eyes could soon learn to trace out yearly rings on the shoot itself.

IV.

The last shoot which I got that day has a whole volume of history in it, and I cannot begin to tell its story unless I should

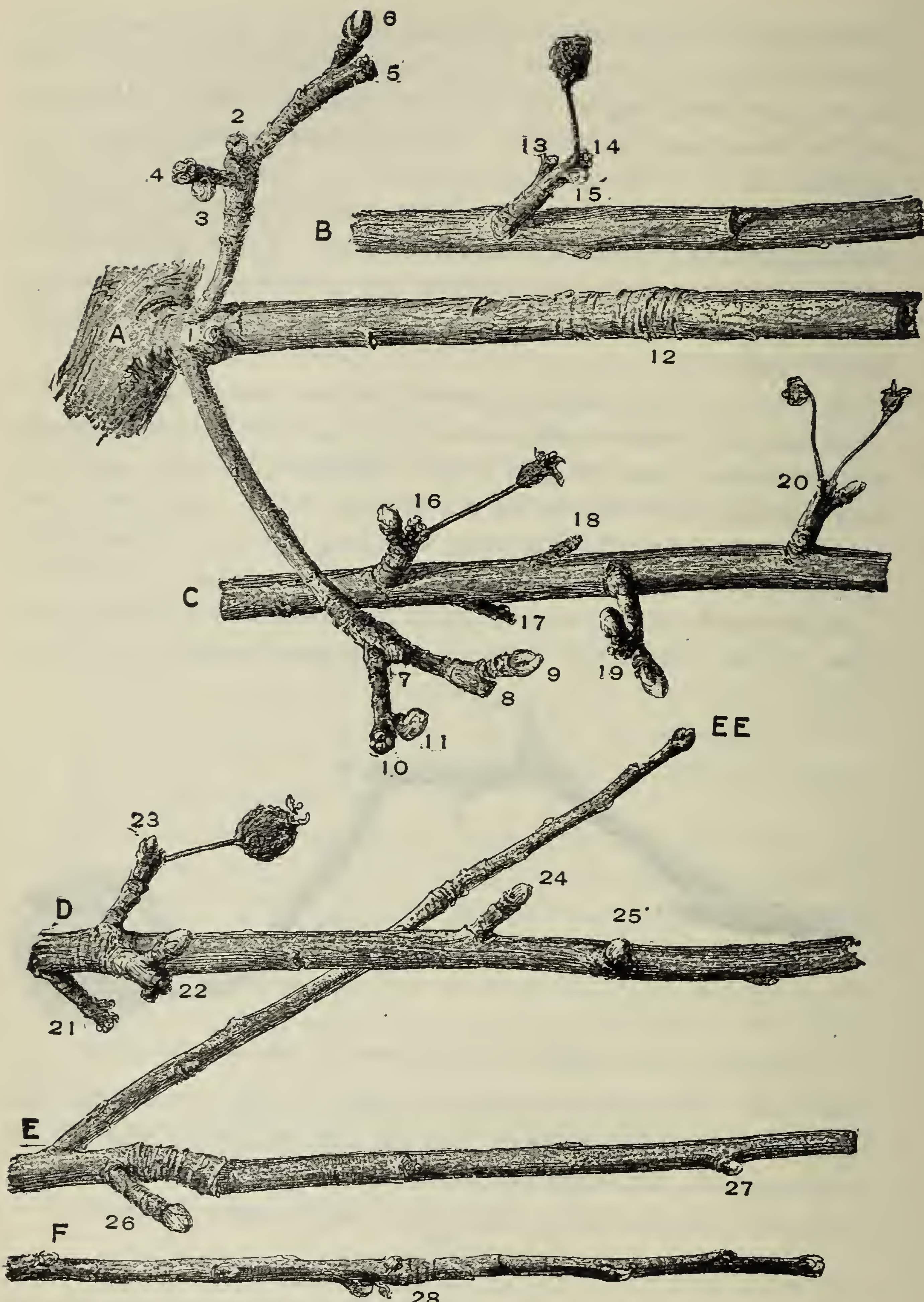


FIG. 22.—*A seven-year old apple twig and its curious history. Half size.*

write a small book. But we will trace out its birthdays and see how many apples it has borne. It is shown in Fig. 22, and because it is so long I have had to break it in two several times to get it on the page. It begins at A, and is continued at B, C, D, E, and F.

Let us count the yearly rings and see how old the whole limb is. These rings are at 28, 26, D, 12, 1,—five of them; and as the shoot grew one year before it made any ring, and another year made no increase in length—as we shall presently see—the whole branch must be seven years old. That is, the limb probably started in 1890.* Let us begin, then, at A, and follow it out.

1890. Started as a spur from the main branch, A, and grew to 1.

1891. Apple borne at 1. This apple did not mature, however, as we can readily see by the smallness of the scar. In this year, two side buds developed to continue the spur the next year.

1892. Gave up its desire to be a fruit-spur, and made a strong growth on to 12. For some reason, it had a good chance to grow. Perhaps the farmer pruned the tree, and thereby gave the shoot an opportunity; or perhaps he plowed and fertilized the land.

In the meantime one of the side buds grew to 3, and the other to 7, and each made a fruit-bud at its end.

1893. Shoot grew lustily,—on to D.

The fruit-bud at 3 bore an apple, which probably matured, as shown by the scar 2. Two side buds were formed beneath this apple to continue the spur next year.

The fruit-bud at 7 bloomed, but the apple fell early, as shown by the small scar. Two side buds were formed.

The buds upon the main shoot—1 to 12—all remained dormant.

---

* It is really impossible to tell whether the shoot started from the limb A in 1889 or 1890, without knowing the age of A; for the spur may have developed its blossom bud at the end in either the first or second year of its life. That is, young fruit-spurs sometimes make a blossom bud the very year they start, but they oftener "stand still" the second year and delay the blossom bud until that time.

1894 Shoot grew from D to beyond E.

Side bud of 2 grew to 4, and made a fruit-bud on its end; the other side bud grew on to 5, and there made a fruit-bud.

Side bud of 7 grew on to 10, and the other one to 8, each ending in a fruit-bud.

Buds on old shoot—1 to 12—still remained dormant.

Some of the buds on the 1893 growth—12 to D—remained dormant, but some of them made fruit-spurs,—14, 16, 17, 18, 19, 20, 21, 22, 23.

1895. Shoot grew from beyond E to 28.

Flowers were borne at 4 and 5, but at 4 the fruit fell early, for the five or six scars of the flowers can be seen, showing that no one of them developed more strongly than the other; that is, none of the flowers "set." A fairly good fruit was probably borne at 5. At the base of each, a bud started to continue the spur next year.

Upon the other spur, flowers were borne both at 8 and 10. At 10 none of the flowers set fruit, but a side bud developed. At 8 the fruit partially matured, and a side bud was also developed.

The buds upon the old stem from 1 to 12 still remained dormant.

Some of the spurs on the 1893 growth—12 to D—developed fruit-buds for bearing in 1896.

Some of the buds on the 1894 growth—D to beyond E—remained dormant, but others developed into small fruit-spurs. One of these buds, near the top of the 1894 growth, threw out a long shoot, starting from E; and the bud at 26 also endeavored to make a long branch, but failed.

1896. Main shoot grew from 28 to the end.

The side bud below 4 (where the fruit was borne the year before), barely lived, not elongating, as seen above 3. This branch of the spur is becoming weak and will never bear again. The side bud of 5, however, made a fairly good spur and developed a fruit-bud at its end, as seen at 6.

The side bud of 10 grew somewhat, making the very short spur 11. This branchlet is also getting weak. The bud of 8, however, developed a strong spur at 9. Both 11 and 9 bear fruit-buds, but that on 11 is probably too weak ever to bear fruit again. In fact, the entire spurs, from 1 to 6 and 1 to 9, are too weak to be of much account for fruit-bearing.

This year several of the spurs along the 1893 growth—12 to D—bore flowers. Flowers were borne from two buds on the first one (at 13 and 14), but none of the flowers "set." One of the little apples that died last June still clings to the spur, at 14. A side bud, 15, formed to continue the spur in 1897. Flowers were borne at 16, 20, 21 and 23, but no apples developed. Upon 16 and 20 the flowers died soon after they opened, as seen by the remains of them. Upon 23 one of the flowers set an apple, but the apple soon died. The spurs 17 and 18 are so weak that they have never made fruit-buds, and they are now nearly dead. The spurs 19 and 22 have behaved differently. Like the others they grew in 1894 and would have made terminal fruit-buds in 1895, and would have borne fruit in 1896; but the terminal buds were broken off in the fall or winter of 1894, so that two side buds developed in 1895, and each of these developed a fruit-bud at its end in 1896 in the spur 19, but only one of them developed such a bud in 22. Upon these spurs, therefore, the bearing year has been changed.

Upon the growth of 1894—D to beyond E—only three spurs have developed, Nos. 24, 25, 26. These started out in 1895, and two of them—25 and 26—have made large, fat buds which are evidently fruit-buds. The shoot at E grew on to EE, and all the buds on its lower two-year old portion remained dormant.

On the 1895 growth—from beyond E to 28—all the buds remained dormant save one, and this one—27—made only a very feeble attempt to grow into a spur.

The buds upon the 1892 growth—1 to 12—are still dormant and waiting for an opportunity to grow.

What an eventful history this apple twig has had! And yet in all the seven years of its life, after having made fifteen efforts to bear fruit, it has not produced a single good apple! The fault, therefore, does not lie in the shoot. It has done the best it could. The trouble has been that the farmer either did not give the tree enough food to enable it to support the fruits, or he did not prune the tree so as to give the twig light and room, or he allowed apple-scab or some other disease to kill the young apples as they were forming. I am wondering, therefore, if, when the trees fail to bear, it is not quite as often the fault of the farmer as it is of the trees?

To the Teacher:

This is the third of a proposed series of leaflets designed to suggest methods of presenting nature-study upon common-place subjects. This is a new field of effort for the College of Agriculture, and we therefore look upon the methods as largely experimental. We are endeavoring to determine the best way of interesting children in country life. You can give us many suggestions, and we should like a free expression of your opinions and experiences. It should be borne in mind that the object of these lessons is not to impart direct and specific information, but to train the child in the powers of seeing and inquiring. We suggest that you familiarize yourself thoroughly with the apple twigs in these four lessons, and then collect a few twigs and examine them for yourself. When you think that you understand such twigs, collect some more (or have the children collect them), and giving each pupil one, conduct an observation on them. If this work is done now whilst the twigs are dormant, you will find the children to be greatly interested in the trees when the buds begin to burst. Once the inquiry is started, you will no doubt be able to conduct other similar observations from time to time. If questions come up which you cannot answer, write them to us and we may be able to help you.

We suggest that you ask your pupils to write short compositions upon these lessons and to make sketches of what they see, and that you send us some of these from time to time in order that we may learn how the experiment is working. We do not care for the best essays alone, but simply the average. The suggestions which we obtain from teachers will aid us greatly in the preparation of future leaflets.

FIFTH EDITION.

No. 4.

JUNE 1, 1897.

TEACHER'S LEAFLETS

FOR USE IN THE PUBLIC SCHOOLS.

PREPARED BY

THE COLLEGE OF AGRICULTURE, CORNELL UNIVERSITY.

ITHACA, N. Y.

Issued under Chapter 128
of the Laws of 1897.

I. P. ROBERTS, DIRECTOR.

A Children's Garden.

BY L. H. BAILEY.

We want every school child in the State to grow a few plants this summer. We want everyone of them to learn something of why and how plants grow, and the best and surest way to learn is to grow the plants and to watch them carefully. We want everyone to become interested in everything that lives and grows. It does not matter so very much just what kinds of plants one grows, as it does that he grows something and grows it the best that he knows how. We want the children to grow these plants for the love of it,—that is, for the fun of it—and so we propose that they grow flowers; for when one grows pumpkins and potatoes, and such things, he is usually thinking of how much money he is going to make at the end of the season. Yet, we should like some rivalry in the matter in every school, and we therefore propose that a kind of a fair be held at the school house next September, soon after school begins, so that each child may show the flowers which he has grown. What a jolly time that will be!

Now, we must not try to grow too many things or to do too much. Therefore, we propose that you grow sweet peas and China asters. They are both easy to grow, and the seeds are cheap. Each one has many colors, and everybody likes them. Now let us tell you just how we would grow them.

1. *The place.*—Never put them—or any other flowers—in the middle of the lawn,—that is, not out in the center of the

yard. They do not look well there, and the grass roots run under them and steal the food and moisture. I am sure that you would not like to see a picture hung up on a fence-post. It has no background, and it looks out of place. The picture does not mean anything when hung in such a spot. In the same way, a flower bed does not mean anything when set out in the center of a lawn. We must have a background for it, if possible,—a wall upon which to hang it. So we will put the flower bed just in front of some bushes or near the back fence, or alongside the smoke-house, or along the walk at the side of the house or in the back yard. The flowers will not only look better in such places, but it will not matter so much if we make a failure of our flower bed; there are always risks to run, for the old hen may scratch up the seeds, the cow may break into the yard some summer night, or some bug may eat the plants up.

Perhaps some of the children may live so near to the schoolhouse that they can grow their plants upon the school grounds, and so have sweet peas and asters where there are usually docks and smartweeds. Grow them alongside the fence, or against the schoolhouse if there is a place where the eaves will not drip on them.

2. *How to make the bed.*—Spade the ground up deep. Take out all the roots of docks and thistles and other weeds. Shake the dirt all out of the sods and throw the grass away. You may need a little manure in the soil, especially if the land is either very hard or very loose and sandy. But the manure must be very fine and well mixed into the soil. It is easy, however, to make sweet pea soil so rich that the plants will run to vine and not bloom well.

Make the bed long and narrow, but not narrower than three feet. If it is narrower than this, the grass roots will be apt to run under it and suck up the moisture. If the bed can be got at on both sides, it may be as wide as five feet.

Sow the seeds in little rows crosswise the bed. The plants can then be weeded and hoed easily from either side. If the rows are marked by little sticks, or if a strong mark is left in the earth, you can break the crust between the rows (with a

rake) before the plants are up. The rows ought to be four or five inches further apart than the width of a narrow rake.

3. *How to water the plants.*—I wonder if you have a watering-pot? If you have, put it where you cannot find it, for we are going to water this garden with a rake! We want you to learn, in this little garden, the first great lesson in farming,—how to save the water in the soil. If you learn that much this summer, you will know more than many old farmers do. You know that the soil is moist in the Spring when you plant the seeds. Where does this moisture go to? It dries up,—goes off into the air. If we could cover up the soil with something, we should prevent the moisture from drying up. Let us cover it with a layer of loose, dry earth! We will make this covering by raking the bed every few days,—once every week anyway, and oftener than that if the top of the soil becomes hard and crusty, as it does after a rain. Instead of pouring water on the bed, therefore, we will keep the moisture in the bed.

If, however, the soil becomes so dry in spite of you that the plants do not thrive, then water the bed. Do not *sprinkle* it, but *water* it. Wet it clear through at evening. Then in the morning, when the surface begins to get dry, begin the raking again to keep the water from getting away. Sprinkling the plants every day or two is one of the surest ways to spoil them.

4. *When and how to sow.*—The sweet peas should be put in just as soon as the ground can be dug, even before frosts are passed. Yet, good results can be had if the seeds are put in as late as the 10th of May. In the sweet pea garden at Cornell last year, we sowed the seeds on the 20th of April. This was about right. The year before, we sowed them on the 30th. If sown very early, they are likely to bloom better, but they may be gone before the middle of September. The blooming can be much prolonged if the flowers are cut as soon as they begin to fade.

Plant sweet peas deep,—two to three or sometimes even four inches. When the plants are a few inches high, pull out a part of them so that they will not stand nearer together than six inches in the row. It is a good plan to sow sweet peas in

double rows,—that is, put two rows only five or six inches apart—and stick the brush or place the chicken-wire support between them.

China asters may be sown from the middle of May to the first of June. In one large test at Cornell, we sowed them the 4th of June and had good success, but this is rather later than we would advise. The China asters are autumn flowers, and they should be in their prime in September and early October.

Sow the aster seed shallow,—not more than a half inch deep. The tall kinds of asters should have at least a foot between the plants in the row, and the dwarf kinds six to eight inches.

Sometimes China asters have rusty or yellow spots on the undersides of their leaves. This is a fungous disease. If it appears, have your father make some ammoniacal carbonate of copper solution and then spray them with it; or Bordeaux mixture will do just as well or better, only that it discolors the leaves and flowers.

5. *What varieties to choose.*—In the first place, do not plant too much. A garden which looks very small when the pussy-willows come out and the frogs begin to peep, is pretty big in the hot days of July. A garden four feet wide and twenty feet long, half sweet peas and half asters, is about as big as most boys and girls will take care of.

In the next place, do not get too many varieties. Four or five kinds each of peas and asters will be enough. Buy the named varieties,—that is, those of known colors—not the mixed packets. If you are very fond of reds, then choose the reddest kinds; but it is well to put in at least three colors. The varieties which please you may not please me or your neighbor, so that I cannot advise you what to get, but I will give some lists which may help you.

Amongst all the sweet peas grown at Cornell last year, the following seemed to be best on our grounds:

Dark purple.	*Waverly.*
	Duke of Clarence.
triped purple.	*Gray Friar.*
	Juanita.
	Senator.

Lavender.	*Countess of Radnor.* *Dorothy Tennant.* *Lottie Eckford.*
White.	*The Bride.* *Emily Henderson.* *Queen of England, Alba Magnifica.*
Primrose.	*Mrs. Eckford.*
White flushed with pink.	*Blushing Beauty.* *Katherine Tracy.* *Eliza Eckford.*
Striped or flaked pink.	*Ramona.* *Mrs. Joseph Chamberlain.*
Orange-pink.	*Lady Penzance.* *Meteor.*
Rose-pink.	*Her Majesty.* *Splendor.* *Apple Blossom.* *Boreatton.*
Rose-pink shaded with orange.	*Firefly.* *Princess Victoria.*

At another place or in another season these varieties might not have given us the most satisfaction; but these names suggest some of the colors, if one does not happen to have a seedsman's catalogue handy.

Of China asters, the Comet type—in various colors—will probably give the most satisfaction. They are mostly large-growing kinds. Other excellent kinds are the Perfection and Peony-flowered, Semple or Branching, Chrysanthemum-flowered, Washington, Victoria, and, for early, Queen of the Market. Odd varieties are Crown, German Quilled, Victoria Needle and Lilliput. Very dwarf kinds are Dwarf Bouquet or Dwarf German, and Shakespeare.

Anyone who wants to know more about sweet peas may have our Bulletins 111 and 127, and for China asters Bulletin 90. Our Bulletin 121 has instructions about laying out yards. Instructions on spraying, with formulas, are contained in Bulletin 114.

Now, let us see how many little boys and girls in New York State will raise sweet peas and China asters this year! And we should like them to write us all about it.

23.—*A clump of weeds in the corner by the house,—motherwort and Virginia creeper. How pretty they are!*

To the Teacher:

Will you not help us to interest the children in the life of the gardens and fields? We suggest that you read this simple leaflet to them; and if any of them want a copy for themselves, tell us how many you want and we shall be glad to send them to you.

The leaflets which we have previously issued are:

1. *How a squash plant gets out of the seed.*
2. *How a candle burns.*
3. *Four apple twigs.*

You will receive one upon insects in a few days.

Address,

Chief Clerk,

College of Agriculture,

Ithaca, N. Y.

ITHACA, N. Y., May 11, 1897.

The demand for "The Children's Garden" still continuing, and the season for sweet pea planting being past, it seems to be necessary to say that there are many interesting and satisfactory kinds of flowers which still can be sown. The China Aster (which we have recommended) may still be planted. One of the chief merits of this plant for our purpose is the lateness of bloom, allowing the flowers to be used in the schools after they open in the fall. An excellent flower for sowing during May is the common annual Phlox (*Phlox Drummondi* of the catalogues). Poppies are also satisfactory, but the flowers do not last long. Petunias are also excellent. Balsams, Clarkias, Coreopsis (or Calliopsis), and Zinnias may still be sown.

THIRD EDITION.

TEACHER'S LEAFLETS

FOR USE IN THE PUBLIC SCHOOLS.

No. 5.

JUNE 1, 1897.

PREPARED BY

THE COLLEGE OF AGRICULTURE,
CORNELL UNIVERSITY,
ITHACA, N. Y.

Issued under Chapter 128
of the Laws of 1897.

I. P. ROBERTS, DIRECTOR.

Some Tent-Makers.

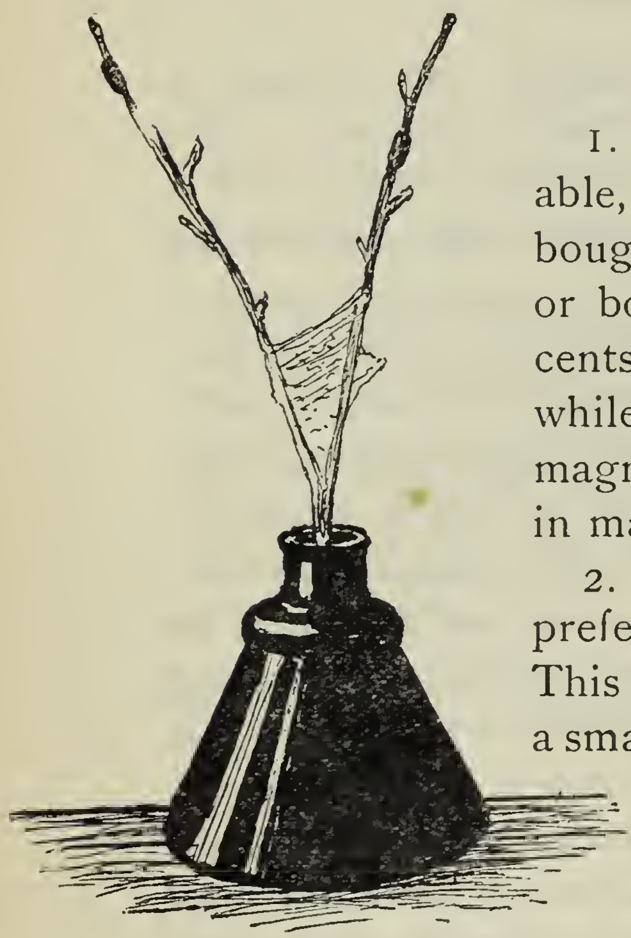
BY ANNA BOTSFORD COMSTOCK.

It is unfortunate that there is, throughout the country, a prevailing dislike for the small creatures called "worms." This dislike is, in most instances, the result of wrong training and is by no means a natural instinct. As evidence of this, witness the joy with which the small boy or even the small girl, handles "bait" when preparing to go fishing; although of all common "worms" surely the angle-worm is least attractive from any point of view. A still more striking example is the hardihood with which young fishermen catch the "dobson" to use as a lure for bass,—for the "dobson" is not only very ugly in appearance but is also vicious, often pinching severely the careless fingers of its captors. Thus the dislike for insects being the result of the point of view, it should be the first duty of the teacher to remove this repulsion. In the lesson which follows there is no occasion for teacher or pupil to touch the insects unless they choose to do so; but an attempt is made to arouse an interest in the habits and ways of insect life. If we can succeed in arousing the child's interest in the actions of a caterpillar, he will soon forget his dislike for the "little brothers" which live upon foliage and which experience miraculous changes of form during their short lives.

In selecting the Apple-tree Tent Caterpillar for this first lesson upon insects, we have been guided by the following facts: First, it is to be found in early spring; second, its life-history from

egg to cocoon is accomplished within the limits of the spring term of our schools: third, it is common everywhere; fourth, it is an important insect from an economic point of view, and the children may be taught how to keep it out of the orchards, thus making the lesson of practical use.

In this lesson the teacher is encouraged to use her own methods and originate new ones to make the work interesting. The leaflet is meant for the exclusive use of the teacher and the text should not be shown to the pupils. The pictures on the last page* are to be shown to the pupils at the teacher's discretion. When answers are herein given to the questions asked, they are meant to aid the teacher in drawing out the correct replies from the children.



24. *The bottle with the twigs bearing the egg masses. The tent is being woven below.*

Materials Needed.

1. A pocket lens or a tripod lens is desirable, but not a necessity. These may be bought from or ordered through any jeweler or bookseller. They cost from twenty-five cents to one dollar apiece. It is well worth while to any teacher to possess one of these magnifiers as a means of interesting her pupils in many ways.

2. A bottle, a broad bottomed one being preferable, so that it will not tip over easily. This bottle is to be filled with water in which a small branch of the apple-tree may be placed to keep it fresh. A common ink bottle will do to begin with. Fig. 24.

3. A wooden or pasteboard box, twelve or fourteen inches square,—a soap box or hat box will do. In place of a cover, nail or paste mosquito netting or cheese cloth over the top; remove the bottom so the box may be placed over the bottle and

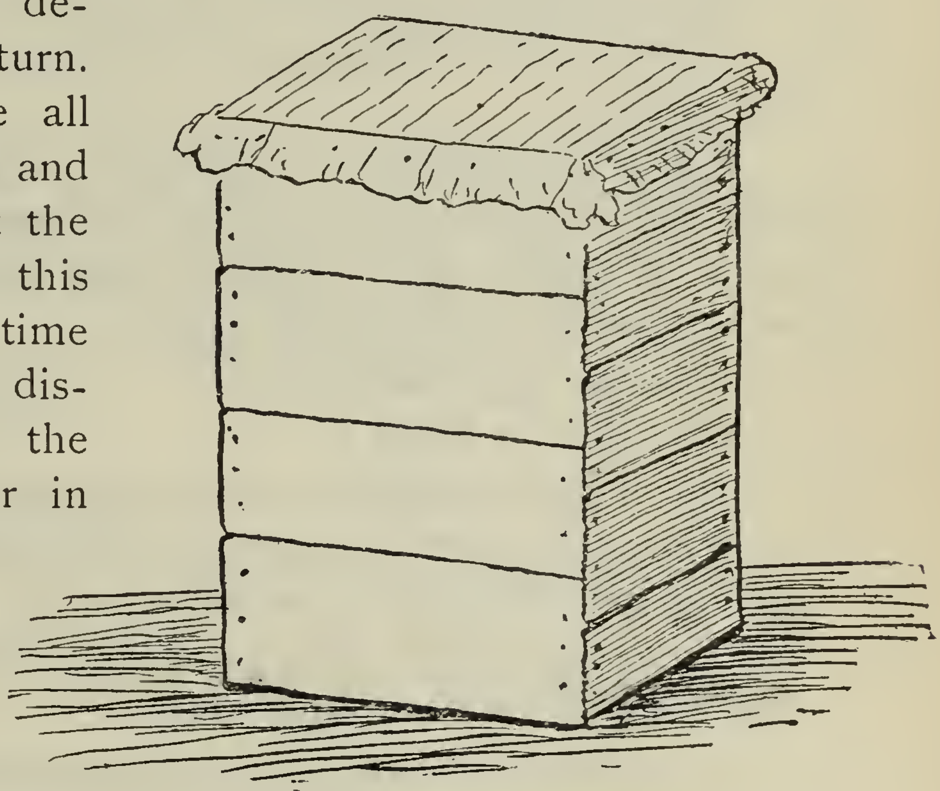
* Teachers who desire to take up this teaching should write us for enough extra sheets of page 47 to supply the scholars.

the branch of apple in it. This is called a breeding-cage and its use is to keep the insects from straying about the schoolroom. Fig. 25.

4. A twig bearing the egg mass of the tent caterpillar. Fig. 27. These are easily found before the leaves appear on apple trees or on wild cherry.

Methods of Using this Leaflet.

The teacher should give the pupils a preliminary talk upon tents. Speak of the tents used by Indians, by armies, by circuses, by campers, and describe them each in turn. The teacher should use all the facts at her disposal, and all her ingenuity to get the children interested in this subject. Spend a little time for two or three days in discussing tents, and get the pupils to tell orally or in essays all they know about tents. When sufficient interest is thus aroused tell them this: "The reason we have talked about tents is because we are going to study some little folks who make tents and live in them. Their tents are not made of bark like the Indian's or of canvas like the soldier's, but are made of the finest silk, which is spun and woven by the tenters themselves. These silken tents are not pitched upon the ground and fastened down by ropes and pegs, for these folk, like the Swiss Family Robinson, live in trees. Many people live in one of these tree tents, and they are all brothers and sisters. Now, just where these tents are made and how they are made, and what sort of little people make them are things which we will find out if we watch carefully and patiently."



25. *The breeding cage.*

Lesson I.—The Eggs. (Fig. 27.)

The teacher having found the egg mass should show it to the pupils and let them, during play hours, collect some for themselves. Say that they are eggs, but explain no farther. Get the children to examine the egg masses and ask the following questions:

On what portion of the trees are these egg masses found?

What is the shape of the egg mass? (Bring out the fact that they look like a portion of the twig swollen or budded.)

What is the color of the egg mass?

Is there much difference in color between the egg mass and the branch?

Has this similarity in color any use? (Develop the idea that the shape and color of the egg mass makes it resemble the twig so closely as to hide it from birds or any animal that would be likely to eat the eggs.)

Does the egg mass shine?

Why does it shine?

Ans. Because there is a coat of varnish around the eggs.

Why was varnish put around the eggs? (Get the answer by asking why varnish is put upon wood. Varnish is put around the eggs to preserve them and keep them dry during the rains and snows of autumn and winter.)

If the eggs are near the hatching period the varnish will have scaled off, revealing the tiny white eggs; if not, let the teacher remove the varnish with a knife or pin, thus exposing the eggs. If the teacher has a lens the children should view the eggs through it. Exhibit the picture, Fig. 28, which represents the eggs greatly enlarged, showing the net work of cement which holds them in place. Ask the children to compare the shape of these eggs with that of bird eggs, and bring out the fact that these are thimble-shaped. Then ask the pupils to guess what sort of a mother laid these eggs, cemented them fast with a net work and then covered them with a coat of waterproof varnish. After sufficient interest is aroused on this point, say to them: "One day last July a little moth or miller was flitting about the

tree from which these twigs were taken. If we could have been there and caught her we would have found her a pretty little creature with four wings covered with down and a soft fuzzy body. In color she was a pale rosy-brown, and had two bands of pale yellow across each front wing." (Call attention to the picture of the moth, Fig. 31.*)

"This is the little mother which laid her eggs in a ring around the twig and covered them with a water-proof coat to keep them safe and sound until this spring, when they will hatch."

What will come out of these eggs when they hatch? The teacher should not answer this question but let the pupils watch the eggs and discover the answer for themselves.

Place the twig with the egg mass upon it in the bottle of water (Fig. 24). It will be best if this twig is a part of a forked branch, so that the caterpillars may make their web upon it. As soon as the eggs hatch, ask the following questions:

What sort of young ones hatch out of the eggs?

Are they like their mother?

What color are they?

Why are their heads so large?

Ans. So that they can gnaw the lid off the egg and thus get out.

Why should the young ones of a pretty moth be little black caterpillars?

(Leave this answer for future investigation.)

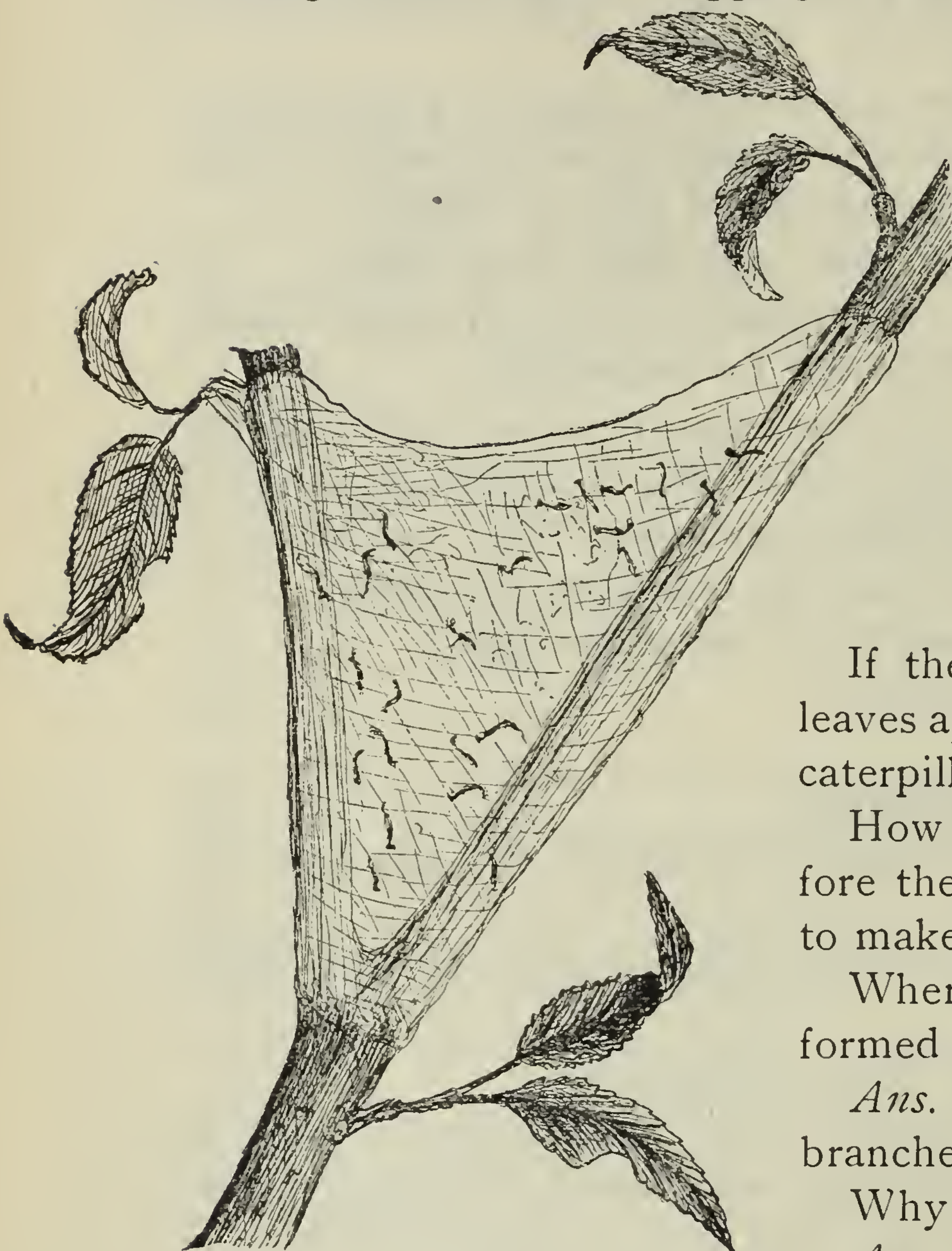
After the caterpillars hatch, it will be necessary to bring in fresh apple twigs with buds and leaves upon them each day so as to feed the little prisoners. It is very desirable that they be kept alive until they have begun their web and have molted at least twice. If they show a disposition to wander off put the breeding cage, Fig. 25, over the bottle and branch and so keep them confined with their food.

To supplement the study of the imprisoned caterpillars, study should be made at the same time of the insects out of doors and

---

* If a specimen of the moth could be obtained it would be much more interesting to the children than the picture. The teacher can collect or breed the moths in July to use the next spring to illustrate the lesson.

under natural conditions. If none appear upon an apple or wild cherry tree near the school-house, the teacher should transfer a colony to such a tree (Fig. 26). This may be done by fastening a twig with an egg mass upon it to a branch of the tree. If too late to get the unhatched eggs, get a nest with the small worms in it and tie that to the convenient branch instead. This study of the insects out of doors is very necessary in discovering their normal habits.



26. *A young colony of tent-makers upon a cherry tree.*

LESSON II.
THE CATERPILLARS.
(Fig. 29.)

If the eggs hatch before the leaves appear, upon what do the caterpillars feed?

How long after hatching before the caterpillars commence to make their tent?

Where is the tent always formed?

Ans. In the fork of the branches.

Why is this so?

Ans. The forking branches offer a convenient support upon which to stretch the tent and when, as is the case out of doors, the tent is spread in a fork of the larger limbs, these limbs afford two branching roads for the caterpillars to follow in searching for food.

Let the pupils make drawings of the tent as soon as it is large enough to be seen well.

What is the color of the caterpillars when they are a week old?

Upon what do they feed?

At what time of day do they feed?

When on a tree, how far from their tent do they go for their food?

Are the paths over which the caterpillars travel when searching for food marked in any way?

Ans. This caterpillar spins a silken thread wherever it goes and therefore leaves a trail of silk behind it.

Of what is the tent made?

Compare the tent with a spider's web and note the differences.

Where does the silk come from, of which the tent is made?

Ans. The silk glands of the caterpillar are situated near the mouth, while those of the spider are on the rear end of the body.

Lesson III. How the Insects Grow.

The caterpillars shed their skins about five times. The first molt occurs about three days after they hatch. The second molt about four days later; and the third molt about six days after the second. After each molt, the color and markings of the caterpillars are somewhat changed. During some of the molts the pupils should watch a caterpillar change his skin. After the class has seen this operation the teacher may give the following lesson:

Where is your skeleton?

What is it made of?

What is it for? Bring out the fact that the skeleton is a support for the muscles and organs of the body.

Where is an insect skeleton? Get as many answers to this question as possible, then say:

The insect's skeleton is on the outside of its body instead of a skin, and the flesh and muscles are supported by it on the inside instead of on the outside like our own. As this skeleton is hard, it cannot stretch; as the insect grows and gets too large it bursts open and the insect walks out of it. Now, underneath this old, hard skeleton a new one is formed which is soft and flexible at first and so stretches to accommodate the growing insect. After a little time this new skeleton also

hardens and has to be shed when it is too small to suit its owner.

Notes should be made by the pupil upon the change of color and markings after the different molts and the process of molting should be described.

Lesson IV. The Pupa. (Fig. 30.)

In ordinary seasons, about the middle of May the caterpillars get their growth. If those in the breeding cage have died or have not thriven, bring in a few full grown caterpillars from the orchard and put them on some branches in the breeding cage. Give them fresh food each day as long as they will eat; also place some sticks and chips around on the bottom of the breeding cage for the worms to "spin up" upon. Then have the children observe the following things:

How do the caterpillars begin their cocoons.

Where are the cocoons made?

How are they made?

Draw a picture of a cocoon?

About a week after a cocoon is made open it carefully with a pair of scissors so as not to hurt the inmate and let the pupils see the change that has come over the caterpillar.

Have the pupils describe the pupa.

Let the pupils make drawings of the pupa.

The moths will hardly emerge from the cocoons until after the close of the school term. The children should be encouraged to gather the cocoons off the fences around the orchards and off the sticks and branches upon the ground and to carry them home. The cocoons may be placed in pasteboard boxes and kept until the moths emerge, about the middle of July.

Lesson V. Destroying the Caterpillars.

After the caterpillars are fully grown and all the processes of growth have been observed by the pupils, the teacher should give a lesson upon the injury which they do to trees and the necessity of keeping the orchards free from these pests. This

lesson should be given guardedly so as not to encourage the children to cruelty in killing insects. The teacher should always try to inculcate in the child reverence for life, that wonderful force, which we can so easily take from a creature but which we may never give back. It is better to appeal to the child's sense of justice in giving this lesson. The teacher may vary it to suit her own ideas, but in substance it might be given as follows:

"All life is sacred; the smallest worm has as good a right to live in the sight of God as you or any child has. Life should never be taken except when necessary. However, no being has the right to interfere with the rights of another. Neither the child nor the worm has any right to trespass upon the property of any one else."

"Let us see whether these caterpillars are trespassers or not. The farmer works hard to earn the money to buy the land upon which the orchard is planted; he works hard to earn the money with which to buy the young trees; he works hard to set out the trees and cultivate the orchard: therefore the orchard and the fruit of it are his property, and he has a right to drive away all thieves. If men or children steal the fruit, he has a right to appeal to the law and have them fined or imprisoned. If worms come and injure the tree by eating up the foliage, he has a right to keep them out if he can. The leaves are necessary to the tree, for if they are destroyed the tree cannot get the air it needs to keep it vigorous and enable it to mature its fruit. We have seen that these caterpillars destroy the leaves, and thus do great injury to the apple crop. We therefore have a right to destroy these little robbers, as that is the only way we can keep them out of our orchards."

How may they be destroyed?

The egg masses may be collected in winter and early spring from young orchards, and be burned.

In old, large trees we must wait until later. Ask the pupils the following questions:

At what times did we find the worms in their tents? *Ans.* Early morning, late afternoons, and during cold, dark days.

If we should destroy the tents in the middle of a warm,

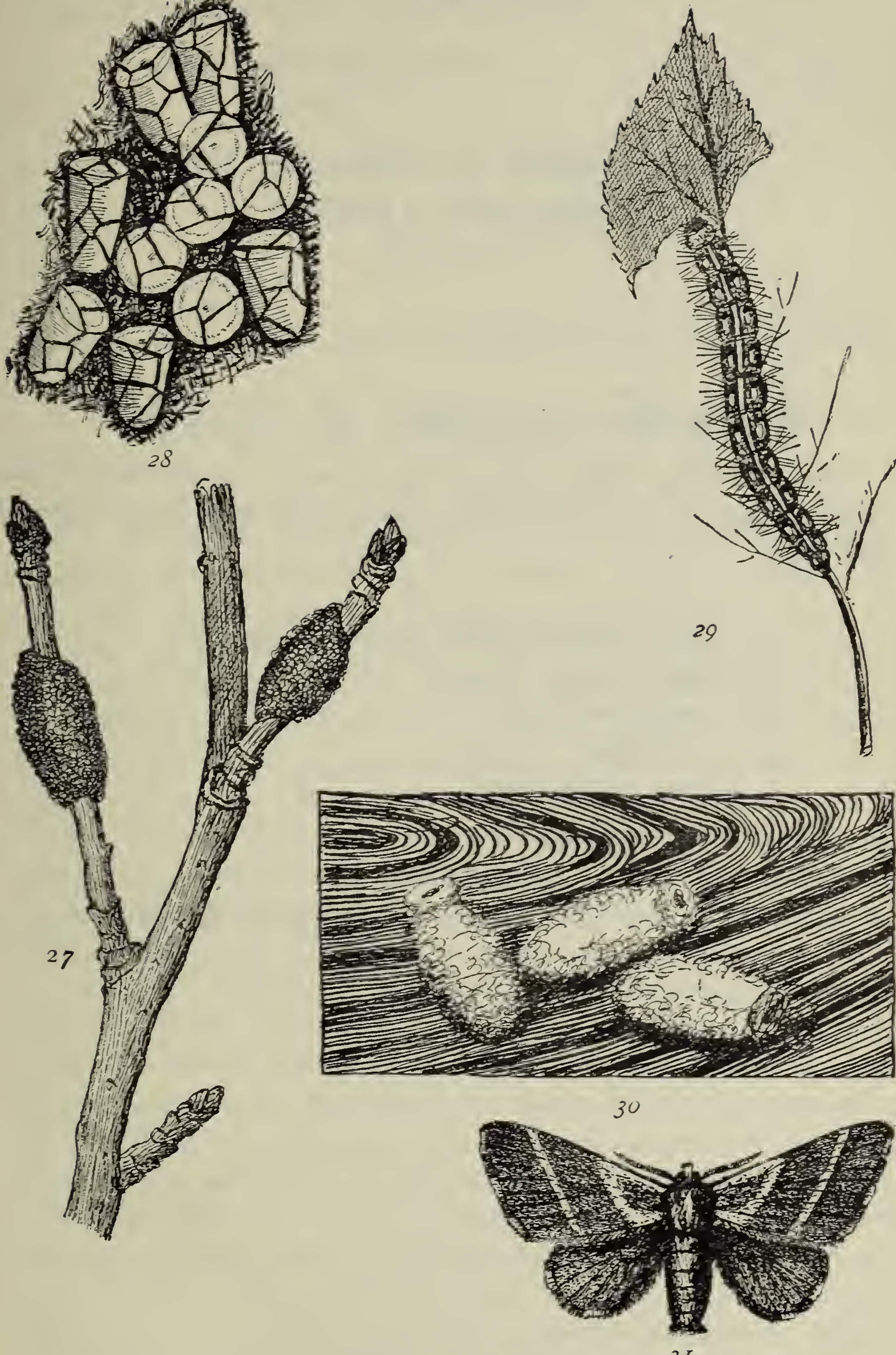
sunny day, what would happen? *Ans.* The caterpillars, being out feeding on the leaves, would not be hurt, and as soon as they came back would make another tent.

If the tent is destroyed in the early morning or late afternoon or on a cold, dark day, what would happen? *Ans.* The caterpillars, all being in the tent, would be destroyed. How may the tents be destroyed? *Ans.* By wiping them out with a long pole on one end of which is wound a rag saturated with kerosene. Or by burning them out with a torch.

Is it best to destroy the caterpillars early in the season, before they have done much damage, or to wait until they are large and have done all the damage they can?

If the trees were sprayed with Paris-green in the early spring, what would happen? *Ans.* The caterpillars would be killed as soon as they commenced to eat, when they were first hatched.

When these caterpillars feed upon the leaves of wild cherry they are doing no damage to an orchard. Therefore, when the tents appear on wild cherry trees have we any right to destroy them? *Ans.* The wise and careful farmer does not allow wild cherry trees to grow along his fences, to become breeding places for insect enemies which will next year attack his orchards.



THE CURIOUS HISTORY OF A TENT CATERPILLAR.

27. *The masses of eggs upon the twigs of an apple tree.* 28. *The eggs enlarged.* 29. *A full-grown caterpillar.* 30. *Cocoons.* 31. *The moth, or adult insect.*

To the Teacher:

The following leaflets have been issued to aid teachers in the public schools in presenting nature-study subjects to the scholars at odd times.

1. *How a squash plant gets out of the seed.*
2. *How a candle burns.*
3. *Four apple twigs.*
4. *A children's garden.*
5. *Some tent-makers.*

Address,
Chief Clerk,
College of Agriculture,
Ithaca, N. Y.

SECOND EDITION.

No 6.

JUNE 1, 1897.

TEACHER'S LEAFLETS

FOR USE IN THE PUBLIC SCHOOLS.

PREPARED BY

THE COLLEGE OF AGRICULTURE,
CORNELL UNIVERSITY,

ITHACA, N. Y.

Issued under Chapter 128
of the Laws of 1897.

I. P. ROBERTS, DIRECTOR.

What is Nature-Study?

BY L. H. BAILEY.

It is seeing the things which one looks at, and the drawing of proper conclusions from what one sees. Nature-study is not the study of a science, as of botany, entomology, geology, and the like. That is, it takes the things at hand and endeavors to understand them, without reference to the systematic order or relationship of the objects. It is wholly informal and unsystematic, the same as the objects are which one sees. It is entirely divorced from definitions, or from explanations in books. It is therefore supremely natural. It simply trains the eye and the mind to see and to comprehend the common things of life ; and the result is not directly the acquirement of science but the establishment of a living sympathy with everything that is.

The proper objects of nature-study are the things which one oftenest meets. To-day it is a stone ; to-morrow it is a twig, a bird, an insect, a leaf, a flower. The child, or even the high school pupil, is first interested in things which do not need to be analyzed or changed into unusual forms or problems. Therefore, problems of chemistry and of physics are for the most part unsuited to early lessons in nature-study. Moving things, as birds, insects and mammals, interest children most and therefore seem to be the proper subjects for nature-study; but it is often difficult to secure specimens when wanted, especially in liberal quantity, and still more difficult to see the objects in perfectly natural conditions. Plants are more easily

had, and are therefore more practicable for the purpose, although animals and minerals should by no means be excluded.

If the objects to be studied are informal, the methods of teaching should be, also. If nature-study were made a stated part of a curriculum, its purpose would be defeated. The chiefest difficulty with our present school methods is the necessary formality of the courses and the hours. Tasks are set, and tasks are always hard. The only way to teach nature-study is, with no course laid out, to bring in whatever object may be at hand and to set the pupils to looking at it. The pupils do the work,—they see the thing and explain its structure and its meaning. The exercise should not be long,—not to exceed fifteen minutes at any time, and, above all things, the pupil should never look upon it as a recitation, and there should never be an examination. It should come as a rest exercise, whenever the pupils become listless. Ten minutes a day, for one term, of a short, sharp and spicy observation upon plants, for example, is worth more than a whole text-book of botany.

The teacher should studiously avoid definitions, and the setting of patterns. The old idea of the model flower is a pernicious one, because it really does not exist in nature. The model flower, the complete leaf, and the like, are inferences, and pupils should always begin with things and not with ideas. In other words, the ideas should be suggested by the things, and not the things by the ideas. "Here is a drawing of a model flower," the old method says; "go and find the nearest approach to it." "Go and find me a flower," is the true method, "and let us see what it is."

Every child, and every grown person too, for that matter, is interested in nature-study, for it is the natural method of acquiring knowledge. The only difficulty lies in the teaching, for very few teachers have had any drill or experience in this informal method of drawing out the observing and reasoning powers of the pupil wholly without the use of text-books. The teacher must first of all feel the living interest in natural objects which it is desired the pupils shall acquire. If the enthusiasm is not catching, better let such teaching alone.

All this means that that the teacher will need helps. He will need to inform himself before he attempts to inform the pupil. It is not necessary that he become a scientist in order to do this. He simply goes as far as he knows and then says to the pupils that he cannot answer the questions which he cannot. This at once raises the pupil's estimation of him, for the pupil is convinced of his truthfulness, and is made to feel—but how seldom is the sensation!—that knowledge is not the peculiar property of the teacher but is the right of any one who seeks it. It sets the pupil investigating for himself. The teacher never needs to apologize for nature. He is teaching only because he is an older and more experienced pupil than his pupil is. This is just the spirit of the teacher in the universities to-day. The best teacher is the one whose pupils farthest outrun him.

In order to help the teacher in the rural schools of New York, we have conceived of a series of leaflets explaining how the common objects can be made interesting to children. Whilst these are intended for the teacher, there is no harm in giving them to the pupil; but the leaflets should never be used as texts to make recitations from. Now and then, take the children for a ramble in the woods or field, or go to the brook or lake. Call their attention to the interesting things you meet—whether you yourself understand them or not—in order to teach them to see and to find some point of sympathy; for everyone of them will some day need the solace and the rest which this nature-love can give them. It is not the mere information which is valuable; that may be had by asking someone wiser than they, but the inquiring and sympathetic spirit is one's own.

The pupils will find their lessons easier to acquire for this respite of ten minutes with a leaf or an insect, and the school-going will come to be less perfunctory. If you must teach drawing, set the picture in a leaflet before the pupils for study, and then substitute the object. If you must teach composition, let the pupils write upon what they have seen. After a time, give ten minutes now and then to asking the children what they saw on their way to school.

Now, why is the College of Agriculture of Cornell University interesting itself in this work? It is trying to help the farmer, and it begins with the most teachable point,—the child. The district school cannot teach agriculture any more than it can teach law or engineering or any other profession or trade, but it can interest the child in nature and in rural problems and thereby fasten its sympathies to the country. The child will teach the parent. The coming generation will see the result. In the interest of humanity and country, we ask for help.

TO THE TEACHER:

The following leaflets have been issued to aid teachers in the public schools in presenting nature-study subjects to the scholars at odd times.

1. *How a squash plant gets out of the seed.*
2. *How a candle burns.*
3. *Four apple twigs.*
4. *A children's garden.*
5. *Some tent-makers.*
6. *What is nature-study?*

Address,

Chief Clerk,

College of Agriculture,

Ithaca, N. Y.

TEACHER'S LEAFLETS

FOR USE IN THE PUBLIC SCHOOLS.

No. 7.

JUNE 1, 1897.

PREPARED BY

THE COLLEGE OF AGRICULTURE, CORNELL UNIVERSITY,

ITHACA, N. Y.

Issued under Chapter 128 of the Laws of 1897.

I. P. ROBERTS, DIRECTOR.

Hints on Making Collections of Insects.

BY ANNA BOTSFORD COMSTOCK.

IT is the purpose of this leaflet to give a few suggestions to aid those pupils of the secondary schools, who desire to make collections of insects.

There are several good reasons why children should be encouraged to make collections of flowers, birds and insects; and the least of these reasons is the possession of such a collection on the part of the child. Making a collection of natural history specimens should only be the means to an end, *i. e.*, training the child to observe. When eyes are opened to the wonders of nature, every roadside, brook, and woodland is fraught with interest which is undreamed of to those who are nature-blind. It is sad to think of the hosts of people who go through this beautiful world having eyes but seeing not, having ears but hearing not. The eyes must be unsealed in youth, when the mind is alert and receptive if the man or woman is to find in later life that nature is not only a resource and recreation but an ever faithful friend holding out comforting arms to those who are weary in soul and body.

Not only does the study of nature open the child's eyes, but it also teaches him the value of accuracy. The young naturalist

soon understands that an observation is worth nothing unless it is truthful. On the other hand, nature-study cultivates the imagination. The wonders in the lives of insects, plants and birds are so illimitable that almost anything *seems* possible. Few indeed are the studies wherein the fire kindled by imaginative *seeming* is guarded and checked by the facts of actual *seeing*.

There are a few points in favor of beginning with insects when the child first attempts making a collection of natural objects. Insects are to be found everywhere and are easily caught; and it requires no technical skill to preserve them as is the case with birds; while they retain their natural forms and colors better than do flowers. To secure the desired results for the pupil when he is making his collection of insects the teacher should take care that he makes his observations incidentally; thus subserving the true methods of nature-study, which is to teach the child while he remains unconscious of the fact that he is being taught. The teacher should therefore ask the young collector "Where did you catch this butterfly?" "Where did you find this beetle?" "Upon what plant or flower did you find this bug?" "Did you hear this cricket chirp? If so, how did he do it?" etc., etc. Thus making him tell orally or in a written language lesson the things he has seen while collecting. The differences in the appearance and structure of the insects caught should also be brought out by questions. These questions may be adapted to pupils of any age and the success of this part of the work must ever depend upon the interest and genius of the teacher.

The objection is sometimes raised that collecting and killing insects and birds incite the child to cruelty and wanton destruction of life. This seems good *a priori* reasoning but experience does not confirm it. We have always found that those who collect and take an interest in insect life are much more careful about killing or hurting insects than are other people; the entomologist of all men taking the greatest pains to avoid stepping upon the caterpillar or cricket in his path; also the young ornithologists who have come under our observation show the greatest devotion to the rights and interests of birds. Our experience is that as soon as the child begins to take an interest in insects he begins to see matters from their point of view and this insures a proper regard for their right to life. It will be well, however, for the teacher to impress upon the pupil that he should kill no insect that is not desired for his collection.

DIRECTIONS FOR COLLECTING AND PRESERVING INSECTS.

The articles necessary for collecting insects are few and inexpensive. One net and one killing bottle may do service for a grade or an entire country school, thus reducing the expense to a minimum.

INSECT NET. Fig. 1.

Materials required:

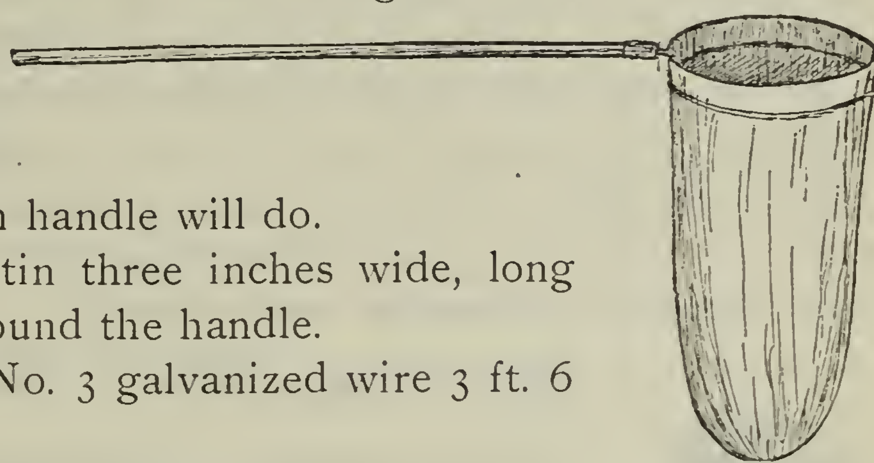


FIG. 1. *Insect net.*

1. A handle about three feet long; an old broom handle will do.
2. A piece of tin three inches wide, long enough to reach around the handle.
3. A piece of No. 3 galvanized wire 3 ft. 6 in. long.
4. 1/6 yard of heavy sheeting.
5. 3/4 yard of cheese cloth.

Bend the wire into a ring about a foot in diameter and bend back about 3 inches of each end of the wire so they may be inserted into a hole drilled into the end of the handle. The piece of tin should be fastened around the end of the handle where the wire is inserted to hold it securely in place. If practicable a tinsmith should be called upon to help in bending the wire and fastening it to the handle. After this is done take the sheeting and fold it over the wire double, using only enough to fit around the wire without gathering; the object of this heavy cloth is to prevent the net from wearing out quickly. Make the cheese cloth into a bag with rounded bottom and just wide enough to fit the facing of sheeting to which it should be sewed securely, and the net is finished.

HOW TO USE THE NET.

The net must be swung swiftly to be successful. Insects have many eyes and are very wide-awake and have no desire to be caught; therefore, the collector must be very active if he gets anything. One method of using the net is called "sweeping"; to do this take the handle about a foot and a half above the ring and pass the net quickly back and forth,

striking it against the grass in front of you as you walk through open fields; the net must be turned at each stroke and kept in rapid motion or the insects will escape. After a time the net should be examined and the insects put in the killing bottle.

Another method of using the net is called "beating." This method is used in collecting insects from bushes and consists of lifting the net, mouth upward, and striking it sharply against the branches or leaves, thus jarring the insects into it.

To use the net in water sweep the water plants as quickly as possible. In running streams overturn stones, holding the net just below them with the mouth up stream. An old dipper made into a sieve by perforating the bottom with an awl is a good utensil for collecting water insects.

THE KILLING BOTTLE, FIG. 2.

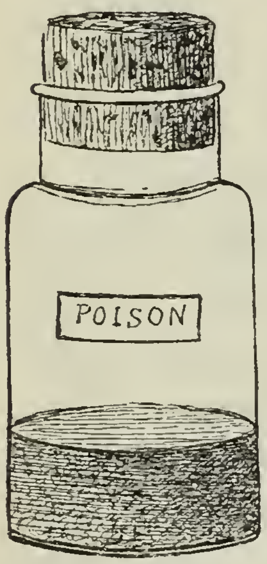


FIG 2. *Killing bottle.*

It is desirable to kill the insects in a humane way so that they will not suffer by the process; it is also desirable that they should not revive after they are pinned, both for their own sakes as well as for the sake of the feelings of the collector. The best way to secure painless and sure death for the insects is by the means of a "cyanide bottle."

Materials needed for a killing bottle:

1. A bottle with a wide mouth; a morphine bottle or a small olive or pickle bottle will do. Even a glass fruit-can holding a pint will answer very well, although taking off and putting on the cover consumes more time than is desirable.

2. A cork that will fit the bottle tightly and is long enough to handle easily.

3. Two cents' worth of cyanide of potassium.

4. One cent's worth of plaster of Paris.

These latter materials may be procured from any drug store.

Place the lump of cyanide of potassium in the bottle and pour in enough water to cover it. Add immediately enough plaster of Paris to soak up all the water; leave the bottle open in a shady

place for an hour and then wipe the dry plaster of Paris from its sides, put in the cork, and it is ready for use. The plaster of Paris forms a porous cement which, while it holds the cyanide fast in the bottom, also allows the fumes of the poison to escape and fill the bottle. It should be labeled "poison." If kept corked when not in use a killing bottle made like this will last a whole season.

The first rule in using the killing bottle is this: Do not kill any more insects than you need for your collection. The second rule is: do not breathe the fumes of the bottle; for they smell badly and are not good for you. When you uncork the bottle to put an insect in it hold it away from your face and cork it up again as quickly as possible.

Some insects may be caught from flowers, etc., directly into the bottle by holding it uncorked beneath them for a moment; the fumes of the poison soon overcome them and they drop into the bottle. In taking insects from the net take the bottle in the right hand and the cork in the left; insert the bottle into the net and place the mouth of it over an insect crawling on the inside of the net, then put the cork on the outside of the net into the mouth of the bottle, net and all, for a moment until the insect falls into the bottom of the bottle; then remove the cork and take the rest of the imprisoned insects in the same way. Insects should be left in the bottle at least an hour, and may be left in there over night without injury to the specimens.

Fig. 3. *Insect pins 1, 3, 5, are German insect pins. 2, is a steel mourning pin.*

Insect Pins. Fig. 3.

After the insects are caught they should be pinned so that they may be arranged in the collection in an orderly manner. Common pins are not good for pinning insects; they are too thick and they corrode very soon, covering the specimens with verdigris. Regular insect pins are desirable as they are very slender and do not corrode so quickly. These may be obtained of any dealer in entomological supplies at a cost of fifteen cents per hundred.

Ask for the German insect pins Nos. 1, 3 and 5. If these pins are too expensive you

can use the black steel mourning pins. These come in shallow boxes one by two inches square and have round glass heads and the boxes are labeled "Germany"; these may be procured from any dry goods store. However, insects pinned with any beside regular insect pins cannot be sold or exchanged.

All insects except beetles should be pinned through that part of the body just back of the head as shown in Figs. 11, 13, 14, 15. Beetles should be pinned through the right wing-cover as shown in Fig. 12. About one-fourth of the pin should project above the back of the insect. Very small insects may be gummed to a narrow strip of cardboard and the pin put through the cardboard.

LABELING SPECIMENS.

Specimens should be labeled with the date of capture and the locality. Thus the butterfly, Fig. 15, would be labeled thus:

Ithaca, N. Y.
Aug. 12, 1896.

The paper on which this label is written should be slipped upon the pin with which the butterfly is pinned and placed just below the insect. Labels should be as small as possible and neatly cut.

INSECT BOXES.

For the beginner nothing is more convenient than an empty cigar box, which may be obtained at any store where cigars are sold. (Fig. 4.) The bottom of the box should be covered with

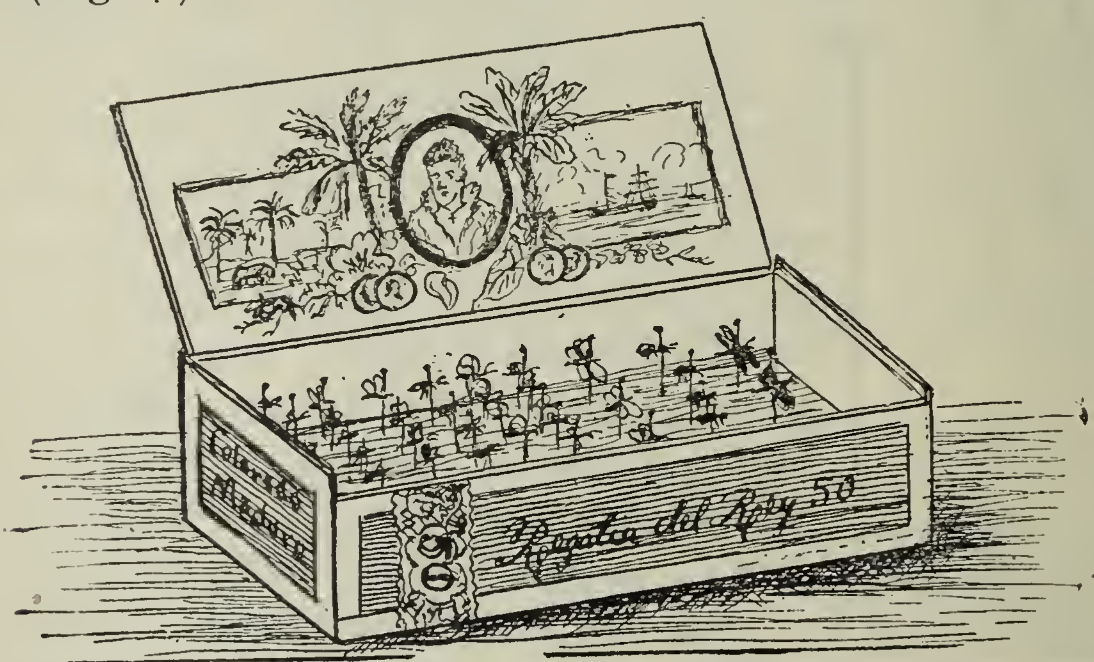


FIG. 4. *A convenient box for the use of the young collector.*

some soft, firm material into which pins may be pushed without bending them. There are many such materials. Sheet cork or pressed peat may be obtained of dealers in entomological supplies. Some ingenious boys use regular bottle corks cut into cross sections about ¼ inch thick. Others take the pith of dried corn-stalks divided in half lengthwise. The cheapest and most easily procurable of the purchasable materials is cork linoleum. This is for sale in most carpet stores. Get the quality that is about ¼ inch thick which costs about $1 per yard; put it into the box cork-side up. Any of these materials may be fastened to the bottom of the box with glue or with tacks. In all cases they should be covered neatly with white paper for the insects appear better against a white background.

For permanent collections the wooden boxes with glass tops are much safer; and as the insects may be seen through the glass these boxes are more practical for school collections. This kind of a box is shown in Fig. 5. Its sides are 18 by 16 inches and its

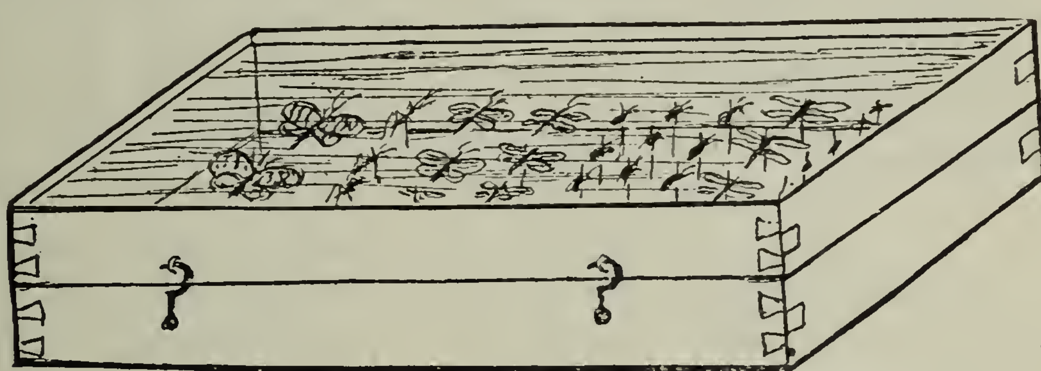


FIG. 5. *Insect box made of wood, with glass top.*

height is three inches outside measure. The upper edge of the sides of the bottom of the box is made with a tongue which fits into a groove made in the lower edge of the sides of the cover. This is done so that the top and bottom parts of the box shall fit very closely together in order that museum pests cannot get in and destroy the specimens.

Fig. 6 shows a cross-section through one side of the box, showing how it should be made and giving measurements. In the drawing the glass is fitted into a groove in the inner side of the cover. This glass might be puttied in like a window pane if it is found difficult to make the groove. The corners of the box may be mitred and dove-tailed or mitred and nailed; the latter is

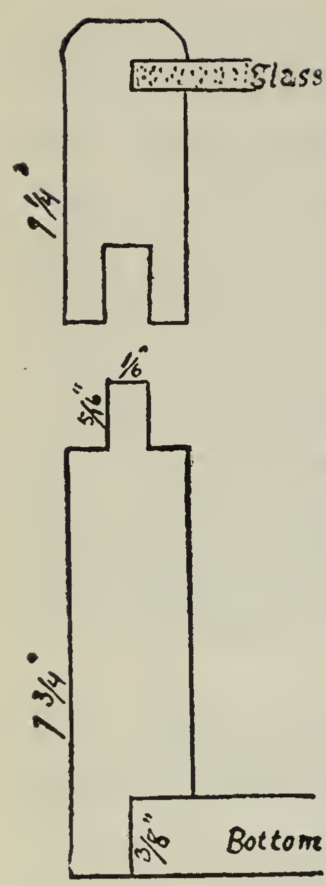


FIG. 6. *A cross-section of the side of insect box* FIG. 5, *showing method of construction and giving measurements.*

more easily done. Any carpenter or cabinet maker can make this box; but great care must be taken to use only thoroughly seasoned wood in its construction. Otherwise the bottom will be sure to warp and shrink and leave cracks through which the museum pests will enter.

The cost of such a box will vary from $0.75 to $1. Basswood should be used in the construction; pine is not at all suitable on account of the resin in it. Screw eyes may be put into these boxes and they may be hung on the walls of schoolroom like pictures.

Museum Pests.

These are small beetles which find their way through the narrowest crevice into the insect boxes and lay their eggs on the pinned insects. The larvæ when they hatch work within the specimens at first but after a time destroy the bodies entirely. The presence of these little rascals may be detected by dust on the bottom of the box just below the infested insect. As soon as this dust is observed, pour into one corner of the box a tablespoonful of carbon bisulphide, or benzine, and close the box quickly. The teacher or parent should put these substances into the boxes as the first is a poison and the latter is very inflammable. As a method of preventing the beetles from attacking the collection it is well to fasten a "moth ball" into one corner of the box. These may be obtained at a drug store.

SPREADING BOARD.—FIG. 7.

Butterflies and moths look much better in a collection when their wings are extended at right angles to the length of the body. To arrange them thus we have to use what is termed a spreading-board.

Materials needed for a medium sized spreading-board.

1. Two strips of pine or other soft wood 18 inches long, 1 ½ inches wide and ½ inch thick.

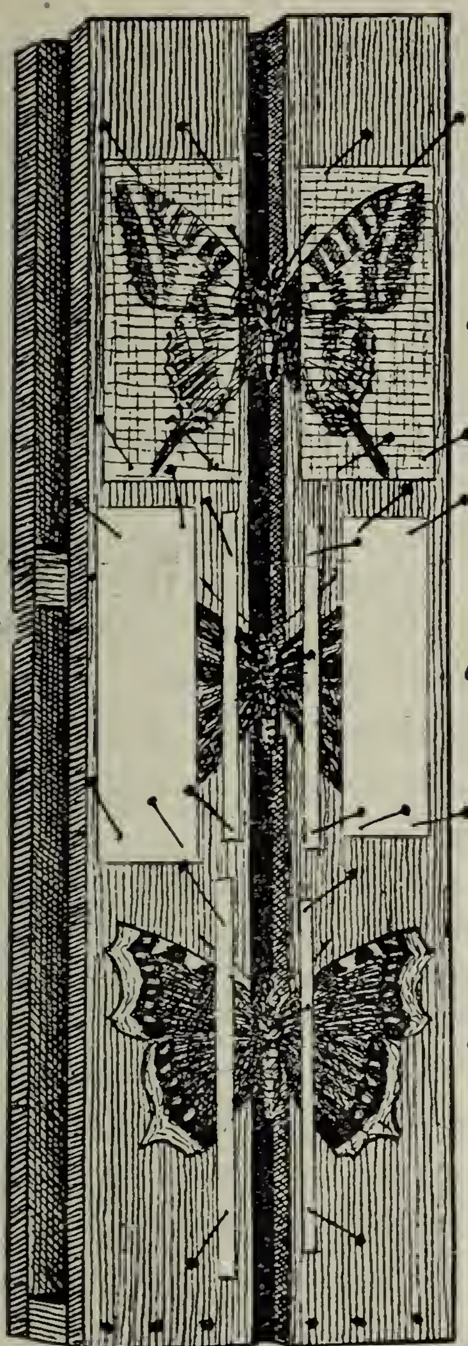


FIG. 7. *A spreading board.*

2. One strip of wood 18 inches long, 3¼ inches wide and ½ inch thick.

3. Two cleats 3¼ inches wide, ¾ inch high and ½ inch thick; and two cleats one inch wide and as high and thick as the others.

4. A strip of cork or linoleum 17 inches long and a little less than an inch wide.

To construct the spreading board take the two narrow strips of wood, place them one-fourth inch apart and on the under side fasten them across the ends to the longer cleats. Then on the same side as the cleats tack the piece of cloth or linoleum over the space between the strips of board, and as the cleats are one-half inch wide the linoleum should cover all the space left. Then midway the boards fasten the two smaller cleats. Fig. 8 shows a cross-section of the spreading board just in front of these two middle cleats. Now it is ready for the bottom board which will fit exactly if directions are followed, and this completes it. The space between the two upper boards is wide enough to take in the body of the moth or butterfly. The cork or linoleum below the space will hold firmly the pin on which the butterfly is impaled. The cleats hold the top and bottom boards apart and so protect the points of the pins.

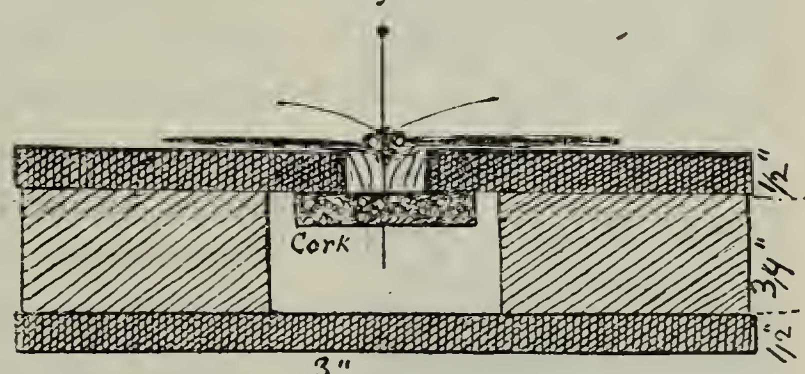


FIG. 8. *A cross-section of spreading board in front of the cleat "d" in Fig. 7.*

Spreading boards may be made much smaller or much larger to suit moths of different sizes; the space between the top boards must always be large enough to admit the body of the insect.

To use the spreading board: insert the pin with the butterfly on it into the linoleum just far enough so that the body of insect will be in the space between the boards up to the wings, Fig. 8. Place the wings out flat on the board and fasten them there with narrow strips of paper pinned across them, Fig. 7, *a*. While held down by these strips of paper arrange them so that the hind margins of the front wings shall cover the front margins of the hind wings and shall be in a line at right angles to the body; then pin larger pieces of paper over the rest of the wings, Fig. 7, *b*. Sometimes isinglass is used instead of paper to hold the wings down, Fig. 7, *c*. The insects should be left on the spreading board at least three days; and when the board has insects on it, it should be kept in a box where the museum pests and mice cannot get at it.

Sometimes when the moths are not spread soon after being killed they become so stiff that the wings cannot be moved without breaking them. In such cases the insects should be put on some paper in a jar which has some wet sand in the bottom and which can be covered tightly. The air in such a can is so moist that in two or three days the insect will become limber and may be spread with ease.

AN AQUARIUM. FIG. 9.

An aquarium with living, moving insects in it is a very interesting ornament for the window-sill of a schoolroom. A glass candy jar or even a butter jar may be transformed into such an aquarium thus: first, put into the jar a layer of sand about two inches deep; in this sand plant some small water weeds and then add a layer of gravel or pebbles; then nearly fill the jar with rain water, pouring it in carefully so as not to disturb the plants.

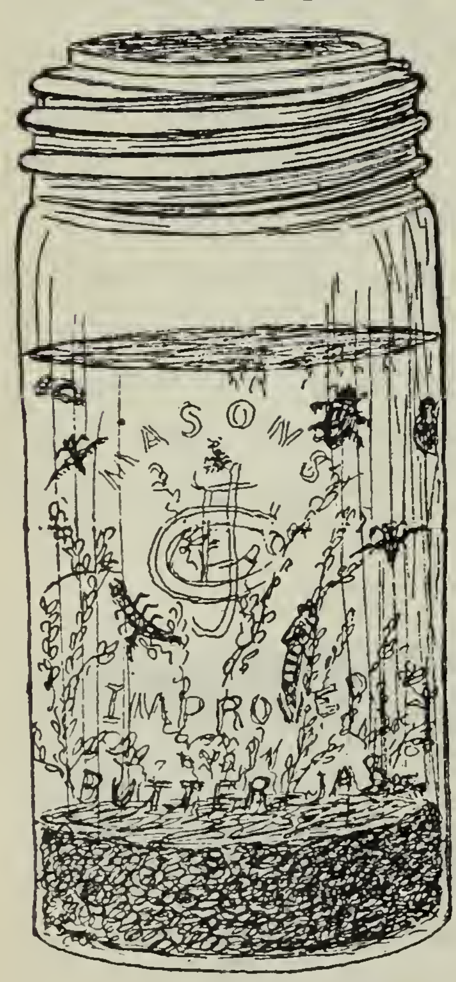


FIG. 9. *An aquarium.*

The plants will keep the water in a right condition for the water insects to live in; more water should be added from time to time to replace that which evaporates. In such an aquarium place any insects found in water and watch their habits.

Where to Collect Insects.

The border of a piece of woods where many shrubs and weeds are growing is an especially good place for collecting many kinds of insects. Any place where there is a great variety of plants and flowers will give a variety of insects. Banks of streams and underneath stones in the fields are good places for collecting.

When to Collect Insects.

The best time of the year is during the summer months. The best times of day is in the forenoon after eight o'clock; and in the twilight at evening.

At night many moths may be caught by making a paste of sugar and water (unrefined sugar is best) and painting it upon tree trunks with a brush after sunset. The paste should cover a space two inches wide and several inches long. After dark seek these places cautiously with a lantern and moths will be found sucking the paste: these may be caught with the killing bottle if you move carefully so as not to frighten them; they do not seem to mind the light of the lantern.

Electric street-lights attract many insects which may be caught in the net. A lamp set in an open window is also a very good lure on warm nights in the spring and summer.

Arranging the Insects in Boxes.

After collecting insects comes the desire to arrange them properly; putting together in neat rows those that resemble each other. To classify insects correctly requires much study. The scope of this leaflet admits of only a few suggestions about the most common insects.

Dragon Flies.—There are many kinds of these but they all have four wings, finely netted and transparent, the hind wings being as large or larger than the front wings. These are perfectly harmless insects.

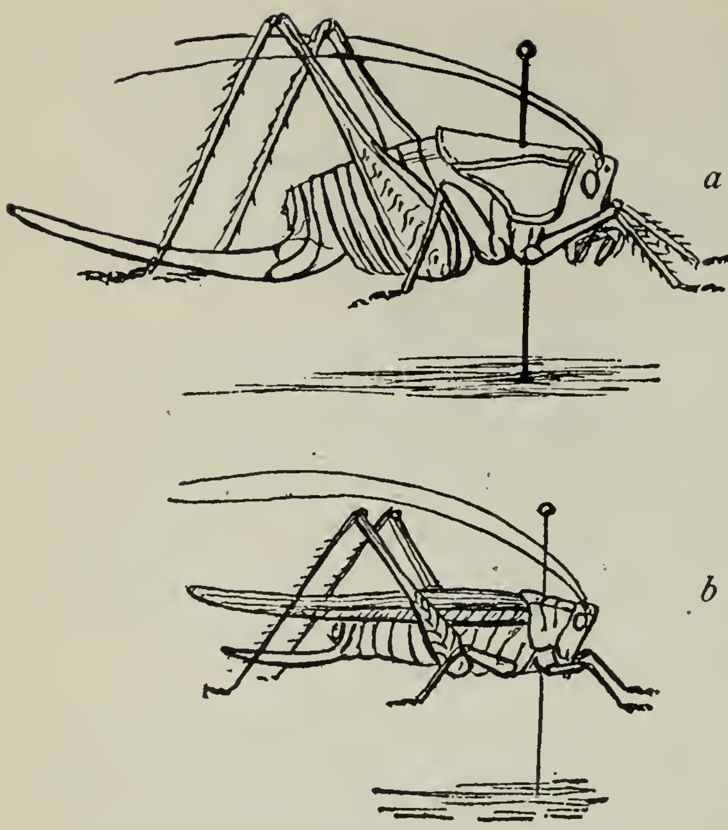


FIG. 10. *a, Cricket. b, Grasshopper.*

Grasshoppers, Crickets and Katydids.—These are known to all, Fig. 10. There are two families of grasshoppers; those with long horns or antennæ and those with short antennæ. Katydids, crickets, cockroaches and walking-sticks are near relatives to the grasshoppers.

Bugs.—These insects have the front pair of wings thick and heavy at the base and thin and transparent at the tips, Fig. 11, *b*. The squash bug, the chinch bug, and the electric light bug are examples of these. Some bugs have the front wings entirely thin and transparent and sloping like a steep roof over the back of the insect like the cicada, Fig. 11, *b*; and the Brownie bug, Fig. 11, *c*, *d*.

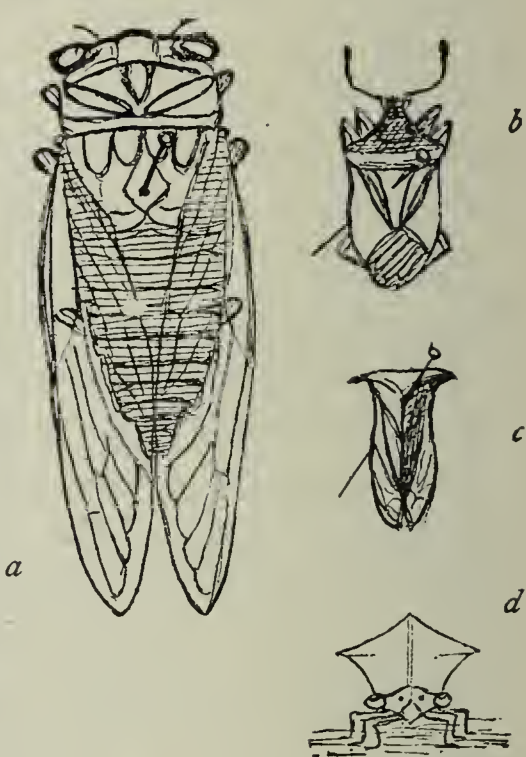


FIG. 11. *a, Cicada. b, Stink-bug. c, Leaf-hopper. d, Leaf-hopper—front view.*

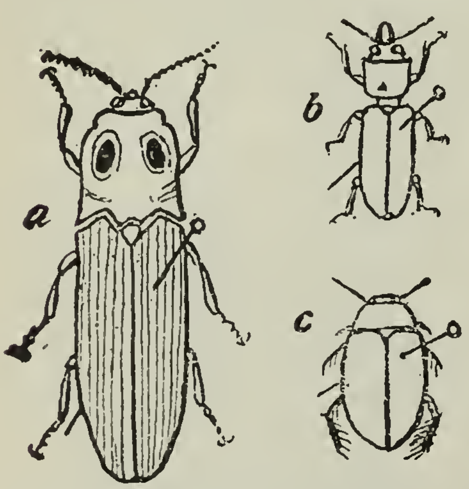


FIG. 12. *Beetles—showing the pin through the right wing cover. a, Snapping beetle. b, Wood-boring beetle. c, Water beetle.*

Beetles. — These have hard wing-covers which meet in a straight line down the back and have a pair of thin wings folded under them, Fig. 12. The "June bug" or "May beetle" and the potato beetle are good examples of beetles.

Flies.— These have only two wings, usually transparent. Behind each of these wings a short thread with a knob on it extends out on each side of the body instead of hind wings, Fig. 13.

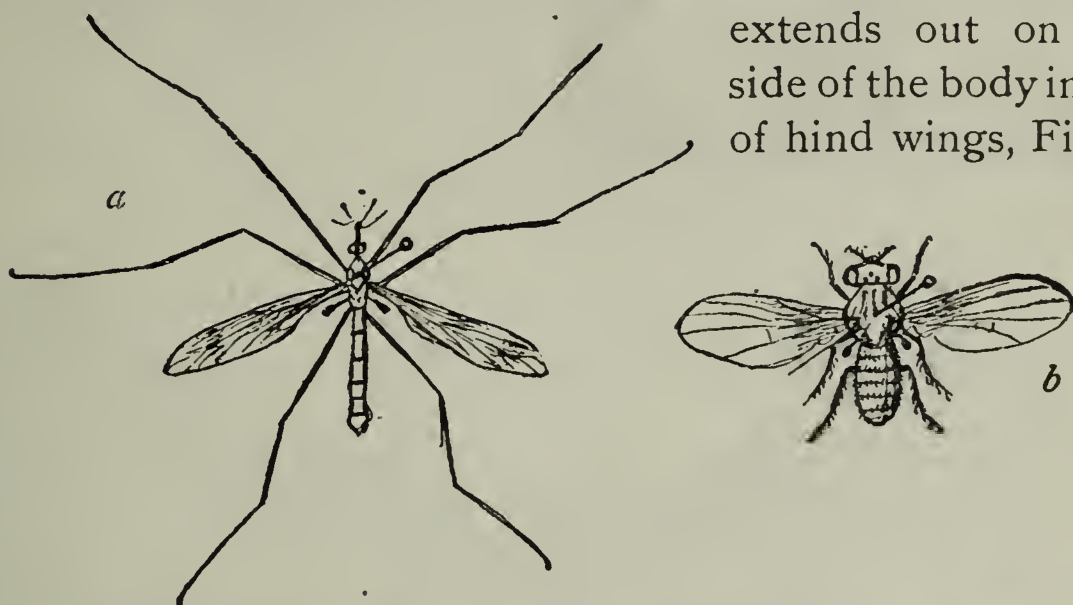


FIG. 13. *Flies—showing the knobs just below the wings. Note that flies have only two wings. a, Crane fly. b, Pomace fly—enlarged.*

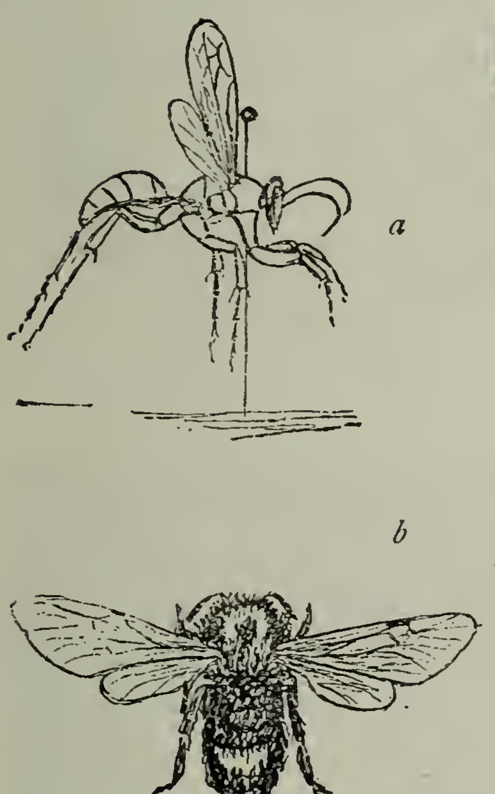


FIG. 14. *a, Wasp. b, Bee. Note these have four wings.*

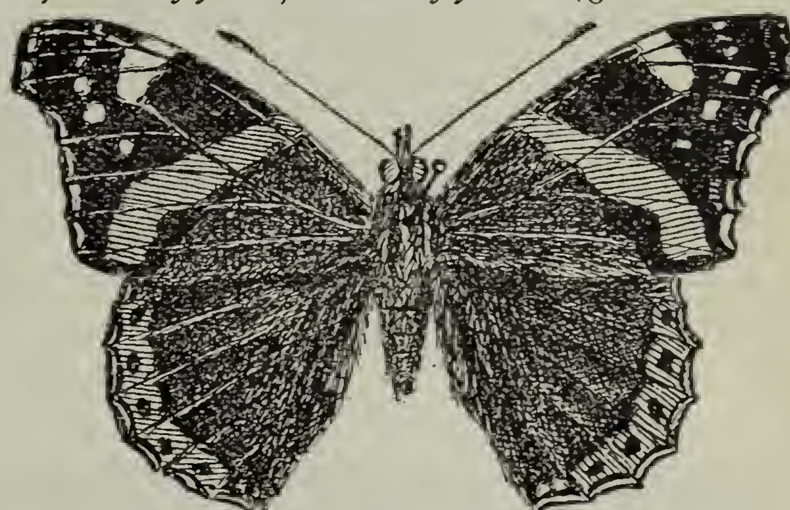


FIG. 15 *The Red Admiral Butterfly. Note the knobbed antennæ.*

House-flies, horse-flies and mosquitoes are examples of flies.

Bees, Wasps and Ants.— Bees, wasps and the winged form of ants have four transparent wings, Fig. 14. Some flies resemble bees and wasps but if examined it will be found that they have only two wings instead of four.

Butterflies and Moths.— Butterflies and moths may be told apart by the following character: The antennæ or horns of the butterflies are always threadlike and knobbed at the tip, Figs, 15, 16, while the antennæ of moths are in various shapes, but never bear knobs at the tips, Figs. 17, 18, 19, 20.

FIG. 17. *The Bass-wood leaf-roller moth.*

FIG. 16. *The Cabbage Butterfly.*

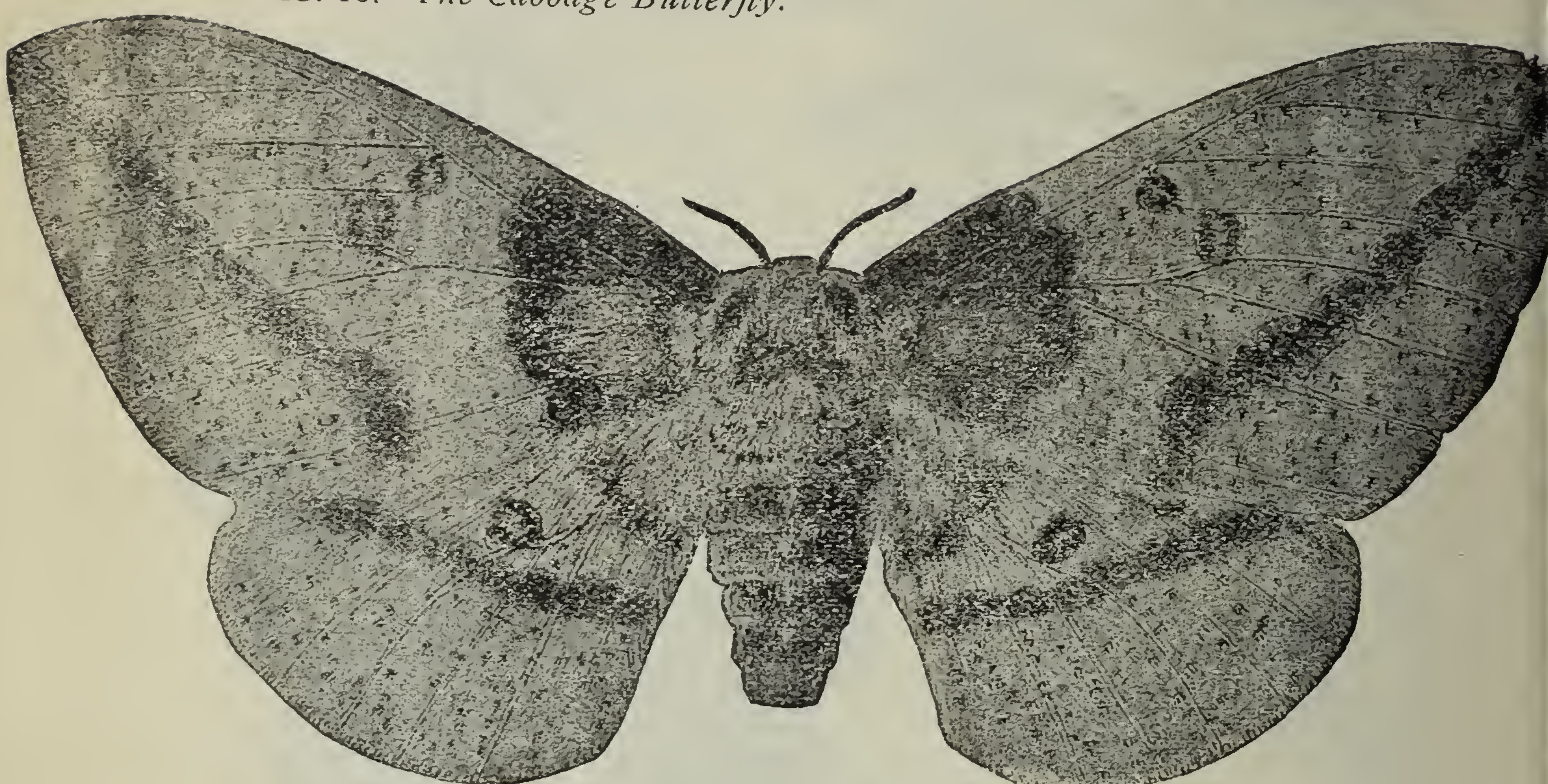


FIG. 18. *The Imperial Moth. A common night-flying moth.*

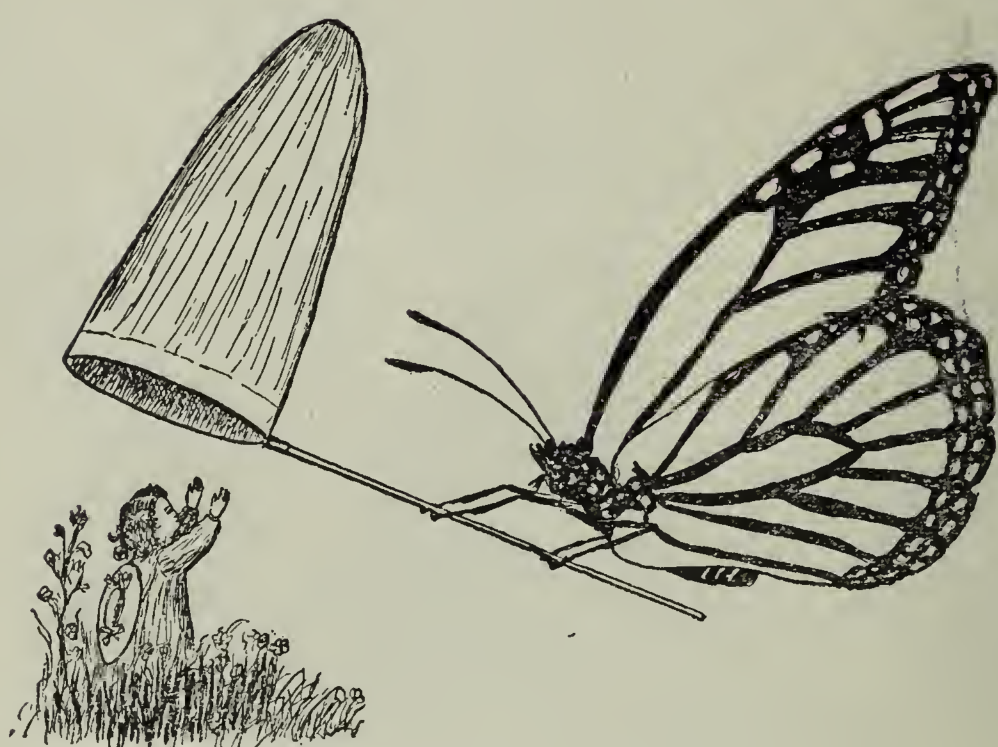
FIG. 19. *An Under-wing Moth.*

FIG. 20. *The Luna Moth. A common night-flying moth.*

DEALERS IN ENTOMOLOGICAL SUPPLIES.

The following is a list of the dealers in entomological supplies that have advertisements in the current American entomological journals :

A. Smith & Sons, 269 Pearl Street, New York, N. Y.
John Akhurst, 78 Ashland Place, Brooklyn, N. Y.
M. Abbott Frazar, 93 Sudbury Street, Boston, Mass.
Entomological Society of Ontario, Victoria Hall, London, Ont.
Queen & Co., 1010 Chestnut Street, Philadelphia, Pa.
The Bausch & Lomb Optical Company, 515-543 N. St. Paul Street, Rochester, N. Y.



State of New York—Department of Agriculture.

SIXTEENTH ANNUAL REPORT

OF THE

BOARD OF CONTROL

OF THE

NEW YORK
Agricultural Experiment Station,

(GENEVA, ONTARIO COUNTY.)

FOR THE YEAR 1897,

With Reports of Director and Other Officers.

TRANSMITTED TO THE LEGISLATURE JANUARY 14, 1898.

WYNKOOP HALLENBECK CRAWFORD CO.,
STATE PRINTERS,
NEW YORK AND ALBANY.
1898.

STATE OF NEW YORK.

No. 73.

IN ASSEMBLY

JANUARY 14, 1898.

SIXTEENTH ANNUAL REPORT

OF THE

Board of Control of the New York Agricultural Experiment Station.

STATE OF NEW YORK:

DEPARTMENT OF AGRICULTURE,
ALBANY, JANUARY 14, 1898.

To the Assembly of the State of New York:

I have the honor to herewith submit the Sixteenth Annual Report of the Director and Board of Managers of the New York Agricultural Experiment Station at Geneva, N. Y., in pursuance of the provisions of the Agricultural Law.

I am, respectfully yours,

CHARLES A. WIETING,

Commissioner of Agriculture.

1897.

ORGANIZATION OF THE STATION.

BOARD OF CONTROL.

GOVERNOR BLACK	Albany.
WILLIAM C. BARRY	Rochester, Monroe County.
S. H. HAMMOND	Geneva, Ontario County.
MARTIN V. B. IVES	Potsdam, St. Lawrence County.
A. C. CHASE	Syracuse, Onondaga County.
F. O. CHAMBERLAIN	Canandaigua, Ontario County.
F. C. SCHRAUB	Lowville, Lewis County.
NICHOLAS HALLOCK	Queens, Queens County.
LYMAN P. HAVILAND	Camden, Oneida County.
G. HOWARD DAVISON	Millbrook, Dutchess County.

OFFICERS OF THE BOARD.

MARTIN V. B. IVES	*President.*
W. O'HANLON	*Secretary and Treasurer.*
S. H. HAMMOND, W. C. BARRY, F. O. CHAMBERLAIN, F. C. SCHRAUB, LYMAN P. HAVILAND, G. HOWARD DAVISON,	*Executive Committee.*

STATION STAFF.

W. H. JORDAN, Sc. D	Director.
L. L. VAN SLYKE, PH. D	Chemist.
WM. P. WHEELER	First Assistant.
S. A. BEACH, M. S	Horticulturist.
VICTOR H. LOWE, B. S.	Entomologist.
* F. A. SIRRINE, M. S	Entomologist.
* F. C. STEWART, M. S	Mycologist.
FRANK H. HALL, B. S	Editor and Librarian.
GEO. W. CHURCHILL	Agriculturist and Sup't of Labor.
C. G. JENTER, PH. C	Assistant Chemist.
WENDELL PADDOCK, B. S	Assistant Horticulturist.
† W. H. ANDREWS, B. S.	Assistant Chemist.
J. A. LECLERC, B. S.	Assistant Chemist.
† A. D. COOK, PH. C.	Assistant Chemist.
C. P. CLOSE, M. S.	Assistant Horticulturist.
FRED D. FULLER, B. S	Assistant Chemist.
† E. B. HART, B. S	Assistant Chemist.
F. THOMPSON, B. S	Assistant Chemist.
FRANK E. NEWTON	Clerk and Stenographer.

Address all correspondence, not to individual members of the staff, but to the NEW YORK AGRICULTURAL EXPERIMENT STATION, GENEVA, N. Y.

The Bulletins published by the Station will be sent free to any farmer applying for them.

* Connected with Second Judicial Department Branch Station.
† Connected with Fertilizer Control.

TABLE OF CONTENTS.

Sixteenth Annual Report

OF THE

Board of Control of the New York State Agricultural Experiment Station.

TREASURER'S REPORT.

GENEVA, N. Y., *October* 1, 1897.

To the Board of Control of the New York Agricultural Experiment Station:

As treasurer of the Board of Control, I respectfully submit the following report for the fiscal year ending September 30, 1897:

Maintenance Account.

Receipts.

1896.			
Oct.	1.	To balance on hand....................	$8,611 75
		To amount received for produce sold....	1,592 12
		To amount received from Comptroller...	37,500 00
			$47,703 87

Expenditures.

By building and repairs	$3,823 80
By chemical supplies	620 52
By contingent expenses	1,651 01
By feeding stuffs	1,428 60
By fertilizers	224 32
By freight and express	449 86
By furniture and fixtures	871 01
By heat, light and water..............	1,858 76

		By labor	$13,637 46
		By library	719 41
		By live stock	121 20
		By postage and stationery	376 02
		By publications	2,440 63
		By salaries	14,615 97
		By scientific apparatus	986 00
		By seeds, plants and sundry supplies	1,213 10
		By tools, implements and machinery	504 63
		By traveling expenses	1,483 16
1897.			
Oct.	1.	By balance	678 41
			$47,703 87

EXPENSE OF BULLETINS AND ENFORCING PROVISIONS OF CHAPTER 955 OF THE LAWS OF 1896.

Receipts.

1896.			
Oct.	1.	To balance on hand	$922 77
		To amount received from Comptroller	10,000 00
1897.			
Oct.	1.	Account overdrawn	1,101 19
			$12,023 96

Expenditures.

By chemical supplies	$692 24
By heat, light and water	826 84
By postage and stationery	41 25
By publications	2,431 62
By salaries	6,609 75
By scientific apparatus	32 00
By traveling expenses	1,390 26
	$12,023 96

Second Judicial Department, Chapter 675 of the Laws of 1894.

1896.		*Receipts.*	
Oct.	1.	To balance on hand	$45 88
		To amount received from Comptroller	8,451 17
			$8,497 05
		Expenditures.	
		By chemical supplies	$44 00
		By contingent expenses	181 23
		By fertilizers	111 55
		By freight and express	36 04
		By furniture and fixtures	17 20
		By heat, light and water	47 15
		By labor	520 09
		By library	127 55
		By postage and stationery	62 68
		By publications	1,342 69
		By salaries	4,122 22
		By scientific apparatus	123 20
		By seeds, plants and sundry supplies	224 44
		By tools, implements and machinery	12
		By traveling expenses	728 50
		By rents	762 05
1897.			
Oct.	1.	By balance	46 34
			$8,497 05

Postage Account, Special Appropriation.

1896.	*Receipts.*	
	To amount received from Comptroller	$500 00
	Expenditures.	
	By postage and stationery	$218 00
	By balance on hand	282 00
		$500 00

Special Appropriation for Repairs to Buildings.

Receipts.

To amount received from Comptroller...	$1,200 00

Expenditures.

By repairs	$1,198 46
By balance	1 54
	$1,200 00

All expenditures are supported by vouchers, approved by the auditing committee of the Board of Control, and have been furnished the Comptroller of the State of New York.

United States Appropriation Under Act of Congress Approved March 2, 1887.

Dr.

1897.		
July	1. To receipts from Treasurer of United States, as per appropriation for fiscal year ending June 30, 1897, as per act of Congress, approved March 2, 1887..	$1,500 00

Cr.

By postage and stationery............	$0 05
By publications	155 68
By salaries	1,264 99
By scientific apparatus	8 85
By seeds, plants and sundry supplies....	30 27
By traveling expenses	40 16
	$1,500 00

WILLIAM O'HANLON,

Treasurer.

DIRECTOR'S REPORT.*

To the Honorable Board of Control of the New York Agricultural Experiment Station:

Gentlemen:— I have the honor to present herewith the report of the New York Agricultural Experiment Station for 1897.

A statement of the efforts and progress of the past year can be no more fittingly prefaced than by an acknowledgment of the earnest support and wise direction which you have given me as your executive officer. I am sensible also of the loyal co-operation of the members of the Station staff in the prosecution of the work which we have undertaken. Moreover, the press of the State and the leaders of agricultural thought and practice have given us most hearty and efficient assistance in securing the means necessary to the development of our equipment; and I am conscious that the intelligent agricultural masses have stood in such an attitude of sympathy towards this institution as to constitute a strong stimulus to vigorous effort in their behalf. This combination of favorable conditions has conspired to make the record of the Station for the year 1897 one which it is pleasant to review.

In my report for 1896, attention was directed to the need of strengthening the work of the Station at several important points. The recommendations which I then made have met with your approval and much has already been accomplished towards re-enforcing old lines of effort and establishing those which are new.

Addition to the Station Staff.

Editor and Librarian.—This most important position has been filled by the selection of Frank H. Hall, B. S., formerly connected with the Office of Experiment Stations in the United States Department of Agriculture.

*Reprint of Bulletin No. 142.

Mr. Hall is a native of Michigan, and graduated from the Michigan Agricultural College in 1888.

After graduation he was elected to an instructorship in mathematics in his alma mater, from which he resigned to accept a position on the United States Geological Survey.

In 1893, Mr. Hall became connected with the Office of Experiment Stations as librarian and proof reader and when he resigned on April 1, 1897, to enter upon his present duties he was connected with the editorial staff of the Experiment Station Record as editor of the department of field crops. His fitness for the peculiar work which he has undertaken in this institution is already shown by the favor with which his popular expositions of the Station bulletins have been received and by the way in which he is proceeding to bring the Station library into a condition of efficiency and availability.

Bacteriologist.—Mr. H. E. Harding, B. S., of the University of Wisconsin, has been elected to the position of bacteriologist. He is to enter upon his duties on January 1, 1899.

Mr. Harding is a graduate of the University of Wisconsin in the class of 1896. For nearly three years he has been pursuing special studies in bacteriology with Dr. H. L. Russell, chiefly with reference to the bacteria of the farm. He has had an intimate knowledge of, and considerable connection with the detailed investigations which resulted in the recent important discoveries of Babcock and Russell concerning the curing of cheese. In June Mr. Harding will go to Europe for study until he takes up his work here.

Dairy Expert.—It was felt that this position should be filled by some one not only entirely familiar with the best methods of the manufacture of butter and cheese, but also with the difficulties and problems which confront New York dairymen. The qualifications of the gentleman selected for this work meet both of these requirements. Mr. George A. Smith is well known in the State of New York not only as the efficient Director of Farmers' Institutes for three years, but also as one of the dairy experts of the New York State Department of Agriculture. Mr. Smith is

an accomplished cheese-maker, and through his intimate and long continued contact with the farmers of the State, he has become well acquainted with the peculiar needs of New York dairying. It is felt that the confidence which the farmers of the State have in Mr. Smith will strengthen the Station with its constituency.

Botanist.—A Station botanist has not yet been chosen. He will be selected with reference to his fitness to take up investigations in plant pathology which, in consideration of the large fruit and vegetable growing interests of the State of New York, is a most extensive and important field of effort.

Other changes.—During the year Mr. W. W. Parker and Mr. E. C. Worden, assistant chemists, have closed their connection with the Station, and Mr. E. B. Hart and Mr. Firman Thompson have been elected to take their places.

Mr. F. C. Stewart, mycologist at the Second Department Branch Station, has been granted a year's leave of absence for further study.

Building Equipment.

Biological and dairy building.—In accordance with the unanimous decision of your Board, the Legislature of 1897 was asked to appropriate $41,000 for the erection of a new building to be devoted to biological and dairy research. This request was granted, there being no apparent opposition. Leading dairymen and horticulturists all over the State contributed to this result by expressing to their representatives in the Legislature their belief that this appropriation would advance the agricultural interests of the State. It must be conceded, moreover, that there is at the present time a tendency on the part of both the National and State Legislatures to recognize generously any just demand coming from farmers.

The money for the erection of this building became available early in April, but the plans and specifications were not placed in the hands of your building committee until nearly the middle of August. Such a delay was exceedingly unfortunate because it has obliged the contractor to proceed with his work during cold weather.

The contract for the erection of the building was awarded to Mr. A. B. Morrison, of Geneva, N. Y., on very satisfactory terms, and its construction has proceeded with expedition so that the walls and roof are practically completed. It is hoped that the building may be available for our use by midsummer.

The following is a summary of the facilities that this building will afford, a somewhat detailed description of which will appear in a subsequent report:

1. Dairy Department. This includes a milk-receiving room, pasteurizing room, cheese-making room, butter-making room, cold-storage room, six cheese-curing rooms and dairyman's office.

The first four rooms are wainscoted in glazed brick with vitrified tile floors and are to be equipped with the very best apparatus for investigation work.

The cheese-curing rooms are to exhibit some unique features in the way of control of temperature and moisture.

2. Bacteriological Department. This includes a laboratory, incubator room, culture room, general work room and office. The temperature of the incubator and culture rooms will be under automatic control, and their use will be shared with the Station botanist.

These rooms will be supplied with compressed air, steam at high pressure, hot and cold water, fuel and lighting gas, and with the most modern apparatus for bacteriological investigations.

3. Botanical Department. The rooms in this department will be a laboratory office and museum, with a joint use of the incubator and culture rooms. The equipment of compressed air, steam, water and gas will be the same as in the bacteriological department, and the equipment of apparatus will be no less efficient.

4. Horticultural Department. The space for this department will include the horticulturist's laboratory, horticulturist's office, assistant horticulturists' office, and two large museum rooms. In many respects these rooms will be equipped similarly to those of the other departments mentioned.

5. Entomological Department. This will contain an office large enough to afford laboratory facilities and a museum room.

The heat for this building will be supplied from twin boilers of twenty-five horse-power each, which will carry a pressure of from sixty to seventy-five pounds, the pressure on the radiators being reduced to five pounds. These boilers will furnish steam for a twenty horse-power engine, which will supply power for running the dairy machinery, the compressor of the refrigerating plant, an automatic compressed air pump, a water pump and other apparatus.

The building is to be equipped with one of the most approved forms of refrigerating apparatus which will be used to secure a low temperature in the cold storage room and such temperatures as are desired in the cheese-curing, bacteriological, cheese and dairy rooms.

The temperature of the building will be automatically controlled by a pneumatic system of temperature regulation. In the offices, laboratories and working-rooms of the dairy department, this control will be applied directly to the valves of the radiators. In the cheese-curing rooms, and to a partial extent in the culture and incubator rooms, the temperature will be regulated through the operation of dampers opening or closing hot and cold air tubes.

New forcing house.—A new building has been added to the forcing house plant, the dimensions of which are 100 by 20 feet. This is to be utilized for investigations in plant nutrition.

Poultry house.—The facilities for poultry investigation have been increased by the erection of a new house. The special features of this building are an incubator cellar where uniformity of temperature can be secured, a series of brooders warmed by hot water, breeding pens of the most approved plan, storage for a large variety of foods, a room for the poultryman and a cooking room.

General repairs.—During the past eighteen months the buildings of the Station have been put in thoroughly good condition. The two houses occupied by Mr. Beach and Mr. Wheeler have been enlarged and renovated throughout, and have been equipped

with bathrooms and new heating apparatuses. The chemical laboratory, the three barns and other outbuildings have also received exterior coats of paint.

Further needs.—I desire to recommend the erection in the near future of a tool shed which shall accommodate all of the machinery which is used on the farm. It will also be wise to build potting sheds with accommodations for various mixtures of forcing house soils in the immediate vicinity of the forcing houses.

LIBRARY.

The three rooms on the west side of the Director's house have been set apart for a library. They have recently been repainted and repapered and are now in a very attractive condition. The largest one is supplied with the tables and chairs necessary in a general reading room. The number of books in the library has been largely increased during the past year by the purchase of complete sets of the journals giving the records of investigation and of such other literature as is useful in an institution of this kind. It has been found possible, also, to practically complete the sets of bulletins and reports of other American stations and of the United States Department of Agriculture. These have been attractively bound and form an important part of our reference library.

In view of the fact that the members of the staff should keep in touch with the current literature of investigation, it has been decided that one-half day of each week shall be set aside as library day. It may be desirable to keep the library open evenings in order that as much time as possible may be available for consulting the journals and other serial publications, the file of which will soon number about one hundred.

PUBLICATIONS.

Reference was made in my last report to the desirability of modifying in some respects the character of the publications from this Station. It was there proposed that the bulletins written

by the members of the staff, to be called the Complete Bulletins, should be full in detail and as scientific in discussion as appeared desirable to the writers. It was also suggested that instead of issuing these bulletins to the entire number of persons whose names are on our mailing list, popular bulletins should be written on the basis of the more complete form which should convey to the agricultural public the results of our work in more simple and less technical language. This plan has been put into execution, and if we may judge from the expressions of approval which have come to us from farmers and from those engaged in work at other Stations, this departure is likely to prove both popular and successful. It is decided, in addition, that the annual reports shall consist only of such matter as is published in the complete bulletins. There seems to be no good reason for printing any great amount of matter in the annual report which does not appear in the bulletins. If any fact or conclusion is worth publishing at all it is proper to give to it the fullest possible circulation among those for whom it has special value.

The Station editor also prepares press reviews, which are sent with the bulletins to all newspapers on our mailing list. It is a matter of gratification that these reviews are very fully and widely printed. This plan not only secures a more widespread attention to our bulletins but also insures accuracy of statement in regard to our conclusions.

Mailing List.

The mailing list of this Station includes several divisions: (1) The officers of the United States Department of Agriculture and of all other experiment stations; (2) the newspapers of this State and a few outside; (3) those persons who desire to receive our complete bulletins; (4) the main list, or those who receive the popular bulletins. The latter list now numbers about thirty thousand names. In two years our mailing list has increased about ten thousand names.

WORK IN THE SECOND JUDICIAL DEPARTMENT.

The expenditure of the appropriation for work in this department has been along much the same lines as in the past years. The needs of the farmers and market gardeners in this section of the State clearly indicate the directions in which they should receive help. The concentration of vegetable and fruit growing, both out of doors and under glass, in the vicinity of New York for so many years has brought about a corresponding concentration of injurious fungi and insects. The aid, therefore, which this Station is able to give to the agriculture of Eastern New York is chiefly in studying new diseases and insects and in illustrating how these pests may be held in check. There seems to be no question but that the policy which has heretofore prevailed in the management of this special work should be materially changed. An attempt has been made to carry on at Jamaica, where this branch effort has its headquarters, more or less scientific research. Such research necessitates an equipment of apparatus and a reference library, and if it is successfully maintained under the present plan, apparatus and library facilities must be duplicated, a policy which is certainly unwise and wasteful. There is no question but that the concentration of the scientific work in the laboratories of the Station at Geneva will be in the interests of economy and efficiency. In this way much more varied and extensive experiments, illustrative and otherwise, can be conducted in different parts of the Second Judicial Department. It is gratifying to know that one of the most intelligent and active agricultural societies in this department has already, by unanimous resolution, approved this change of policy. A very encouraging feature of this action by such a body of farmers was the accompanying declaration that one special line of experiments had already saved to the agriculture of one section of Long Island at least $75,000. In view of the considerations here presented, I shall recommend that this special fund be expended chiefly in maintaining experiments in the field and in forcing houses, which shall be an attempt to illustrate the application to

practical agriculture of the facts discovered in our laboratory research.

It now appears probable that in 1898 attention can be most profitably given to the potato and pickle interests of Long Island. With this in view, arrangements are already being made to locate experiments at at least eight different points, chiefly with reference to the use of fertilizers in potato growing and to the application of a spraying mixture in controlling the diseases which prey upon cucumbers.

Experience teaches that it is not enough merely to discover a fact and point out its relations to practical agriculture. The extreme conservatism of the agricultural class seems to render it necessary to go even farther, and by illustration and by precept upon precept to overcome indifference and skepticism. It is true that such instructional efforts as this are outside of the proper function of the Experiment Station, but conditions seem to require them.

Chemical Department.

Fertilizer analysis.—The demands upon this Station for the inspection of commercial fertilizers are steadily and rapidly increasing. The records show that in no other state are the requirements for this work so heavy as is the case in New York. During the year 1897, 184 manufactures have filed in this office the required statements concerning 1,728 brands of fertilizers. Not all the registered brands are actually sold in the State, but the real number is unnecessarily and even absurdly large. There is not a single good reason for this multiplication of names in the fertilizer trade, but many reasons why such a state of things should not exist. It is a cause of confusion and of unnecessary expense and should hasten a change to a more economical system of buying and selling plant food.

During the season of 1897 three traveling agents were employed by the Station for the collection of samples of fertilizers in different parts of the State. These agents were at work during about four and one-half months, and they collected 1,005 samples, representing 748 different brands. This is less than the

entire number of brands sold. It is impossible with the funds now at the command of the Station for fertilizer inspection to search out and sample in any one year every brand that is sold or offered for sale within the boundaries of the State. As a matter of fact, the work of this kind that is now done is really costing the Station more than the sum appropriated for this purpose. It is entirely safe to say that the appropriation for fertilizer inspection in New York is less in proportion to the necessary work than is the case in any other state. The situation is somewhat perplexing. It would be desirable if some means could be devised to check this useless multiplication of brands, at least so long as it is necessary for the State to inspect them. This could be done, possibly, by imposing an analysis fee upon each brand sold or offered for sale. There are reasons why it would be just to do this. For instance, one company registered in 1897 two hundred and forty-two brands and the effort required for the inspection of these, provided they were all sampled, is a large proportion of the work for the year. This company imposes upon the State an expense which is greatly disproportionate to its sales as compared with other companies offering a greatly less number of brands. It is very certain that if the fertilizer trade continues its present development, either an analysis fee must be imposed or else the State appropriation must be considerably increased. As the matter now stands, a large share of the time of the chemist-in-chief and of four assistant chemists, besides a good deal of attention on the part of the Director of the Station, is devoted to fertilizer inspection. The result is that the efforts of certain Station officers in the direction of investigation are unfortunately limited by this burden of routine work to an extent not justifiable from any point of view. I commend this matter to the attention of your Board as one worthy of serious and careful consideration.

Sugar beets.—Considerable attention has been devoted to sugar beet analysis. This was made necessary by the present active and wide spread discussion of sugar beet production in New York.

About one hundred and fifty samples of beets were analyzed and a general summary of the results is given in Bulletin 135, showing that the average percentage of sugar in the beets was 15.3 per cent. The present indications are that this work will be largely increased in 1898.

Plant nutrition.—Investigations are in progress concerning the plant-food needs of fruits and vegetables and the effect of certain compounds in fertilizers upon the quality of fruits.

The composition of cider and vinegar.—A study of the composition of cider and cider vinegar is now going on with a view to discovering some means of distinguishing between real and artificial or adulterated cider vinegar.

Department of Horticulture.

Of the nine horticultural bulletins issued by the Station in 1897 five discuss plant diseases and the methods of treating them, and one relates to apparatus used in treating insects and diseases which are injurious to plants. It should not be inferred from this that subjects relating to plant pathology occupy two-thirds of the time of the horticultural staff, although it is true that much attention is devoted to work of this kind.

Plum leaf spot.—For several years questions pertaining to the treatment of the leaf spot of plum and cherry have been under investigation. The work which Mr. Fairchild started in 1891 to determine the best means of preventing injury to plum and cherry nursery stock was followed until a satisfactory line of treatment could be confidently recommended. Investigations were then undertaken with the same disease in the orchard. A report of the progress of this work in 1895 was given in Bulletin 98 and the Annual Report for that year. The experiments were continued in 1896 to determine whether the disease may be controlled by two treatments with Bordeaux mixture, 1-to-11 formula, and if so when these treatments should be made. The results, as set forth in Bulletin 117, show that two timely and thorough treatments with this mixture may control the disease on plums in some seasons, but three treatments generally give

best results. The Italian prunes, which were given this treatment, showed an average gain of $24\frac{1}{2}$ pounds of fruit per tree at an extra cost of less than one cent per pound.

Cherry leaf spot.—Cherries ripen so early in the season that it has not yet been found practicable to give them the thorough treatment which is necessary to control the leaf spot, without spotting the fruit with the spray so as to injure its appearance when ripe. This question is still under investigation.

Raspberry anthracnose.—In Bulletin 124 Mr. Paddock gives the results of three seasons' work with the raspberry anthracnose. He finds that it is best to set none but healthy plants and practice a short rotation of crops. The spread of the disease in infested fields was successfully prevented by treatment, but the yield of fruit was not increased enough to make the spraying profitable.

Oat smut.—The treatment of oat smut can hardly be called a horticultural operation, but the general importance of the subject to the agriculture of the State and the need of a bulletin to furnish correspondents with instructions for treating this disease made it desirable that some investigations concerning it should be undertaken. In Bulletin 131 Mr. Close sets forth clearly the results of investigations which were conducted in 1897, partly at the Station and partly on the farm of Messrs. King and Robinson, Trumansburg, Tompkins County. Lysol, a fungicide which has not heretofore been tried against grain smuts, gave excellent results. The most inexpensive treatment, soaking with 0.2 per cent formalin solution, cost for the material 1.4 cents per bushel of seed treated.

Gooseberry mildew.—We have long wished to know something definite as to the comparative value of potassium sulphide and Bordeaux mixture for preventing gooseberry mildew. Mr. Close's investigations on this point are published in Bulletin 133. The best results were obtained when the treatment was begun early in the season, and potassium sulphide proved superior to Bordeaux mixture, lysol and formalin for preventing the disease.

Spray pumps and mixtures.—The constant demand for elementary instruction concerning the use of spray mixtures and spray pumps made it necessary to make further tests of apparatus and revise former instructions so as to include the most recent developments in this line. This has been done by Mr. Paddock and the results are given in Bulletin 121 on Spray Pumps and Spraying.

Effect of wood ashes upon apple scab.—For five years one of the apple orchards at the Station has been devoted to an investigation of the question whether fertilizing the soil liberally with wood ashes may make the apples more resistant to the scab. The results in this investigation are set forth in a bulletin on this subject in which it is shown that, with the conditions under which this investigation was made, immunity from apple scab is not at all increased by liberal applications of hard-wood ashes to the soil.

Forcing tomatoes.—Methods of training and benching tomatoes in the forcing house are discussed in Bulletin 125. The conclusion is reached that, at least in this climate, single stem training is clearly superior to three stem training in forcing tomatoes. Plunging small pots containing the young tomato plants in the soil of the bench to see whether confining the roots thus would bring the plants into bearing earlier or increase their productiveness, showed that practically nothing was gained by this treatment and when used with three stem training it was a detriment.

Varieties of fruit at the Station.—But two bulletins have been prepared in 1897 on the varieties of fruit which are growing at this Station. These are Bulletins 127 on Strawberries and 128 on Raspberries, Blackberries and Dewberries, both by Mr. Paddock.

The following shows the number of varieties of commonly cultivated fruits in the Station collection at the close of 1897, not including plants which were received in the fall of 1897 nor those currants and gooseberries which are grown here simply to illustrate the species to which they belong:

	Number of Station seedlings now growing.	Number of varieties added in fall of '96 and spring of '97.	Total number of varieties now growing at the Station.
Pomaceous fruits:			
Apples	50	108	671
Crab apples	....	1	22
Pears	39	19	240
Quinces	....	2	11
Stone fruits:			
Apricots	....	11	36
Cherries	1	21	75
Peaches	....	17	147
Plums	18	43	243
Small fruits:			
Grapes	446	6	675
Currants	53	10	102
Gooseberries	256	5	479
Blackberries	1	3	34
Dewberries	43	....	49
Raspberries	23	6	123
Strawberries	53	27	113
Total	983	306	3,020

DEPARTMENT OF PLANT PATHOLOGY.

A new disease of sweet corn.—Mr. Stewart has given considerable time to the study of a new disease of sweet corn to which the early varieties of this crop are much subject in the market gardens of Long Island. He has demonstrated that this disease is bacterial in its nature, which is the first step necessary to a discovery of methods of prevention. The subject needs further study, and no remedial measures can now be recommended. Prevention may perhaps be secured by care in the selection of seed and by the planting of resistant varieties.

Potato scab.—The ploughing in of a crop of green rye had no effect in preventing potato scab. The disease appeared to be aggravated rather than checked.

Potato stem blight.—This was not communicated by planting diseased tubers, neither were peppers, tomatoes, egg plants or plants of other species infected by contact with diseased potato tubers.

Carnation rust.—The application of a solution of common salt neither prevented the rust nor benefited the growth of the carnation plants.

Downy mildew on cucumbers.—The early cucumber and pickle industry of Long Island has been in danger of destruction from the ravages of this disease. The experiments of Mr. Stewart in 1896 resulted in materially checking its development by spraying with Bordeaux mixture.

These experiments were repeated at two points in 1897 with similar results. On a small plat of early cucumbers at Floral Park, spraying caused an increased yield of over 30,000 fruits per acre.

On the farm of Mr. Robert Colyer an acre of late cucumbers was sprayed under the direction of Mr. Stewart. The resulting crop was about 102,000 fruits, the average yield with growers who took no pains to control the mildew being not over 20,000 fruits per acre. It is probable that other growers can produce equally large crops when the spraying is done with equal intelligence and thoroughness.

Department of Entomology.

Insectary.—A portion of one of the large greenhouses is being remodeled for use as an insectary. Among other important features it will contain breeding cages of necessary sizes and shapes in which various species of injurious insects can be isolated and their habits studied, root cages for studying insects which attack the roots of plants, and fumigating boxes to be used in testing the effects of various gases upon insects in different stages of development. A dark room also forms an important part of the equipment of the insectary.

The collection of insects.—About 200 species have been added to the Station collection of insects besides valuable biological material illustrating the life histories, habits and injurious work of some of the species already in the collection. The collection now numbers nearly 2,600 species.

Illustrations.—An important part of the work during the past season has been the making of illustrations, photographs and drawings, showing the structure, life histories and habits of in-

jurious insects and their natural enemies. A large number of these illustrations have been made during the past summer. They are kept on file for use in bulletins as needed.

Inspection of nursery stock.—Nursery stock inspection has been continued again this season, but to a less extent than the season previous. About fifteen nurseries have been visited, with the result than ten species of insects, all more or less injurious, have been found on young trees about to be shipped, showing that these insects are distributed by means of nursery stock. The species referred to are as follows: The woolly aphis, peach tree borer, the pistol-case bearer, oyster-shell bark-louse, scurfy bark-louse, plant lice of various species, the bud moth, the New York plum Lecanium, the oak scale and *Aspidiotus ancylus.* The San José scale has also been found in a small nursery in Western New York. Infested stock has possibly been shipped from this nursery for six or eight years past. The present owner is going out of the business and is clearing the land for fruit.

Experiments in dipping young nursery trees infested with plant lice.— Young nursery trees infested with plant lice cannot be sprayed to advantage, as the lice cause the leaves to curl. The lice congregate in great numbers on the under sides of the leaves at and near the tips of the young trees. By dipping these infested tips the insects may be killed. The object of the experiment was to determine the proper strength of the solution (a solution of whale-oil soap) to use. The expense of treating the trees was so slight that no record of it was kept. It was shown that whale-oil soap will kill the lice and may be safely used for this purpose at a strength of one pound to seven gallons of water, but that a stronger solution, one pound to three gallons, will injure the foliage. The weaker solution kills the lice as effectually as the stronger.

Experiments in spraying young nursery trees.— One-year-old apple grafts were sprayed with green arsenite (Scheele's green) one pound to 100 gallons. The trees were badly infested with the canker-worm. This application was made late in June and

was so effectual in destroying the canker-worms that another application was not necessary.

Young cut-leaf birch trees, badly infested with thrips, were sprayed three times with a whale-oil soap in solution, to which was added one ounce of flowers of sulphur to one gallon of the soap solution. This combination proved highly successful, showing that this serious pest can be controlled.

Experiments in fumigating nursery stock with hydrocyanic acid gas.—These experiments are not yet completed, but the indications now are that nursery stock can be successfully fumigated in large frost-proof cellars where the trees are ordinarily stored over winter, without going to the expense of building houses for this purpose where stock can be fumigated in small lots only.

Spraying experiments with green arsenite.—These experiments form a part of a series of experiments with green arsenite begun in 1896, their object being to test the value of green arsenite as compared with Paris green.

Fourteen large trees owned by O. L. Jackson, at Rushville, were used for the experiments and were sprayed three times. Examinations made soon after the first application showed that only the young worms, those about one-fourth inch long, had been killed by the spray. After the third application the trees were practically free from worms, the older ones having finally succumbed.

This indicates that green arsenite may be slow in its action but where the trees were sprayed three times it was effectual.

Investigations and experiments with plant lice.—Four species of plant lice have been under observation during the past season, two infesting the plum and two infesting the currant. The work of studying out the complete life histories of these species is not yet complete. The best progress has been made with *Hyalopterus pruni.* All stages but one have been observed and drawings made. In all the other species studied, with the probable exception of *Myzus*, new facts concerning their life histories have been brought to light, and their various forms figured for the first

time. Nine species of the natural enemies of these insects have also been studied and illustrations made showing the different stages in their development.

Experiments in spraying currant bushes and plum trees showed that these lice may be destroyed if a whale oil soap solution, one pound to seven gallons of water, is properly used.

The cotton-wood leaf beetle.—The investigations and experiments with this insect were finished during the past season.

The field used the previous year was sprayed with green arsenite, former experiments having shown that this insecticide would probably prove the most effectual of any tried. Three applications were made, with the result that the plat was kept almost entirely free from the insects.

In comparing the cost of spraying and running the "bug machines," or "drags," it was found that the spraying could be done at about two-thirds the expense of the other method. It was also found, however, that under ordinary circumstances the best results would be obtained by using the "machine" for a few days soon after the last application of the poison.

DEPARTMENT OF ANIMAL INDUSTRY.

Feeding experiments with chicks and capons.—From an extended test of the relative efficiency of whole and ground grains in feeding chicks and capons it was learned that more food was eaten and a more rapid and profitable gain was made when the ground grain was fed.

Source of milk fat.—An extended and somewhat elaborate investigation concerning the source of milk fat was begun early in the year and the results so far as reached were published in Bulletin 132.

The data show clearly that food fats are not essential to the formation of milk fat, and that the milk fat was not derived wholly from the metabolism of protein; but that probably its origin was partially in the carbohydrates of the food, as has been demonstrated to be the case with body fat.

PRODUCTION OF FIELD CROPS.

An important series of experiments has been begun on the Station farm for the purpose of studying the relative economy of certain systems of maintaining soil fertility.

EDUCATION IN ROAD BUILDING.

The U. S. Department of Agriculture, among other efforts, is endeavoring to disseminate information concerning the construction and economy of good roads. To this end a bureau known as the Office of Road Inquiry has been established.

As one means of accomplishing its purposes this Office is coöperating with the Land Grant Colleges and the Experiment Stations in building in proximity to these institutions samples of roads which shall be an object lesson, especially to rural communities.

The first of these roads was built at New Brunswick, N. J., and the second at Geneva. The latter was built by the united efforts of the Office of Road Inquiry, private citizens, the village of Geneva and the Experiment Station, and is located on North and Castle streets. It extends about twelve hundred feet along the northern boundary of the Station property and runs the entire length of Castle street, the whole distance being about one and a quarter miles.

The manner of construction is what is known as MacAdam, the covering of the road bed consisting of broken stones to the depth of eight inches. On North street the road is eight feet wide and on Castle street the width is fourteen feet for the greater part of the distance, the remainder being twenty feet.

The lower five inches of the covering was obtained from common field stone, and this was surfaced with three inches of broken Hudson River trap rock.

The cost, details of construction and other related facts will be given in the report of the Department of Agriculture. As this road was completed only last October it is too early to draw conclusions as to its quality and durability. It is satisfactory so far and has changed the streets between the Experiment Station and the city from a condition which at times was almost unbearable and prohibitive of travel to one of convenience and comfort.

BULLETINS PUBLISHED IN 1897.

The following is a list of the bulletins issued by the Station for the year 1897. All of these are included in this report excepting Nos. 114, 115, 116, 120, 122, which were presented in the report for 1896.

No. 114—January.—Gooseberries. S. A. Beach. Pages 48.

No. 115—January.—Director's report for 1896. W. H. Jordan, Pages 26.

No. 116—January.—Report of analyses of commercial fertilizers for the fall of 1896. L. L. Van Slyke. Pages 57.

No. 117—March.—Treatment of leaf spot in plum and cherry orchards in 1896. S. A. Beach. Pages 9.

No. 118—March.—Alfalfa. W. P. Wheeler. Pages 10.

No. 119—March.—The downy mildew of the cucumber: What it is and how to prevent it. F. C. Stewart. Pages 30.

No. 120—March.—A practical method of fighting cutworms in onion fields. F. A. Sirrine. Pages 14.

No. 121—March.—Spray pumps and spraying. Wendell Paddock. Pages 23.

No. 122—April.—The pistol-case bearer. V. H. Lowe. Pages 12.

No. 123—April.—Spraying potatoes on Long Island in the season of 1896. F. C. Stewart. Pages 27.

No. 124—April.—Anthracnose of the black raspberry. Wendell Paddock. Pages 14.

No. 125—July.—Forcing tomatoes: Comparison of methods of training and benching. Note on a tomato disease. S. A. Beach. Pages 32.

No. 126—November.—Feeding experiments with chicks and capons: The relative efficiency of whole and ground grains as commonly fed. W. P. Wheeler. Pages 19.

No. 127—November.—Strawberries in 1897. Wendell Paddock. Pages 12.

No. 128—November.—Variety tests with raspberries, blackberries and dewberries. Wendell Paddock. Pages 11.

No. 129—November.—Report of analyses of commercial fertilizers for the spring of 1897. L. L. Van Slyke. Pages 71.

No. 130—December.—A bacterial disease of sweet corn. F. C. Stewart. Pages 17.

No. 131—December.—Results with oat smut in 1897. C. P. Close. Pages 14.

No. 132—December.—The source of milk fat. W. H. Jordan and C. G. Jenter. Pages 34.

No. 133—December.—Spraying in 1897 to prevent gooseberry mildew. C. P. Close. Pages 12.

No. 134—December.—Report of analyses of commercial fertilizers for the fall of 1897. L. L. Van Slyke. Pages 39.

No. 135—December.—The composition and production of sugar beets. L. L. Van Slyke, W. H. Jordan and G. W. Churchill. Pages 30.

No. 136—December.—Inspection of nurseries and treatment of infested nursery stock. V. H. Lowe. Pages 30.

No. 137—December.—Commercial fertilizers for potatoes. W. H. Jordan. Pages 22.

No. 138—December.—Experiments and observations on some diseases of plants. F. C. Stewart. Pages 18.

No. 139—December.—Plant lice: Descriptions, enemies and treatment. V. H. Lowe. Pages 20.

No. 140—December.—Wood ashes and apple scab. S. A. Beach. Pages 27.

No. 141—December.—Digestion and feeding experiments. W. H. Jordan and C. G. Jenter. Pages 30.

No. 142—December.—Director's report for 1897. W. H. Jordan. Pages 20.

W. H. JORDAN,

Director.

N. Y. Agr'l Exp't Station, Geneva, N. Y., Dec. 31, 1897.

NEWSPAPERS AND PERIODICALS PRESENTED TO THE STATION.

Acker & Gartenbau Zeitung, Milwaukee, Wis.

Agricultural Epitomist, Indianapolis, Ind.

Agricultural Gazette of New South Wales, Sydney, N. S. W.

Agricultural Student, Columbus, Ohio.

Agricultural Students' Gazette, Cirencester, Eng.

Albany Weekly Journal, Albany, N. Y.

Allegan Gazette, Allegan, Mich.

American Agriculturist, New York, N. Y.

American Cultivator, Boston, Mass.

American Grange Bulletin and Scientific Farmer, Cincinnati, Ohio.

American Philosophical Society, Proceedings, Philadelphia, Pa.

American Stock Keeper, Boston, Mass.

Angelica Every Week, Angelica, N. Y.

Baltimore Weekly Sun, Baltimore, Md.

Canadian Horticulturist, Toronto, Canada.

Church and Farm, Salt Lake City, Utah.

Cincinnati Society of Natural History, Journal, Cincinnati, Ohio.

Commercial Gazette, New York, N. Y.

Cotton Planters' Journal, Memphis, Tenn.

Dairy World, London, Eng.

Detroit Free Press, Detroit, Mich.

DeRuyter Gleaner, DeRuyter, N. Y.

Elgin Dairy Report, Elgin, Ill.

Farm and Fireside, Philadelphia, Pa.

Farm and Home, Springfield, Mass.

Farm Journal, Philadelphia, Pa.

Farm News, Springfield, Ohio.

Farm Poultry Semi-Monthly, Boston, Mass.

Farm, Stock and Home, Minneapolis, Minn.

Farmers' Advocate, London, Canada.
Farmers' Guide, Huntington, Ind.
Farmers' Home, Dayton, Ohio.
Farmers' Magazine, Springfield, Ill.
Farmers' Voice, Chicago, Ill,
Forester, Washington, D. C.
Geneva Gazette, Geneva, N. Y.
Gentleman Farmer, Chicago, Ill.
Gleanings in Bee Culture, Medina, Ohio.
Green's Fruit Grower, Rochester, N. Y.
Herd Register, Peterboro, N. H.
Hoard's Dairyman, Fort Atkinson, Wis.
Homestead, Des Moines, Iowa.
Horticultural Gleaner, Austin, Tex.
Indiana Farmer, Indianapolis, Ind.
Industrial American, Lexington, Ky.
Iowa Weather and Crop Service Review, Des Moines, Iowa.
Irrigation Age, Chicago, Ill.
Ithaca Democrat, Ithaca, N. Y.
Jersey Bulletin, Indianapolis, Ind.
Journal and Herald, Springville, N. Y.
Long Island Farmer, Jamaica, N. Y.
Louisiana Planter and Sugar Manufacturer, New Orleans, La.
Market Garden, Minneapolis, Minn.
Mirror and Farmer, Manchester, N. H.
Montana Fruit Grower, Missoula, Mont.
Monthly Weather Review, Washington, D. C.
National Nurseryman, Rochester, N. Y.
National Stockman and Farmer, Pittsburg, Pa.
Nebraska Bee-Keeper, York, Neb.
Nebraska Farmer, Lincoln, Neb.
New England Farmer, Boston, Mass.
New England Florist, Boston, Mass.
New York Edition, Farm and Fireside, Springfield, Ill.
New York Farmer, Port Jervis, N. Y.
New York Produce Review, New York, N. Y.

Northwest Pacific Farmer, Portland, Ore.
Olean Herald, Olean, N. Y.
Oregon Agriculturist, Portland, Oregon.
Pacific Coast Dairyman, Tacoma, Wash.
Pomona Herald, Pascoag and Providence, R. I.
Poultry Monthly, Albany, N. Y.
Practical Farmer, Philadelphia, Pa.
Prairie Farmer, Chicago, Ill.
Prattsburgh News, Prattsburgh, N. Y.
Progressive South, Richmond, Va.
Queensland Agricultural Journal, Brisbane, Queensland.
Salt Lake Herald, Salt Lake City, Utah.
Sanitary Inspector, Augusta, Me.
Southern Cultivator, Atlanta, Ga.
Southern Planter, Richmond, Va.
Southern States Farm Magazine, Baltimore, Md.
Southwestern Farmer and American Horticulturist.
State Board of Health Bulletin, Memphis, Tenn.
Suffolk Bulletin, Huntington, N. Y.
Sugar Beet, Philadelphia, Pa.
Vermont Farmers' Advocate, Burlington, Vt.
Wallace's Farmer, Des Moines, Iowa.
Watkins Review, Watkins, N. Y.
West Virginia Farm Reporter.
Western Plowman, Moline, Ill
Woman's Home Companion, Philadelphia, Pa.
Wool Record, New York, N. Y.

REPORT

OF THE

CHEMICAL DEPARTMENT.

L. L. VAN SLYKE, PH. D., CHEMIST.

Assistant Chemists.

C. G. GENTER, PH. C.

W. H. ANDREWS,* B. S.

J. A. LE CLERC, B. S.

A. D. COOK,* PH. C.

F. D. FULLER, B. S.

E. B. HART,* B. S.

F. THOMPSON, B. S.

TABLE OF CONTENTS.

---

*Connected with Fertilizer Control.

REPORT OF THE CHEMIST.

L. L. VAN SLYKE.

I. REPORT OF ANALYSES OF COMMERCIAL FERTILIZERS FOR THE SPRING OF 1897.*

SUMMARY.

(1) Samples collected. During the spring of 1897, the Station collected 735 samples of commercial fertilizers, representing 500 different brands. Of these different brands, 400 were complete fertilizers; of the others, 32 contained phosphoric acid and potash without nitrogen; 33 contained nitrogen and phosphoric acid without potash; 1 contained nitrogen and potash without phosphoric acid; 31 contained phosphoric acid alone; and 3 contained potash salts only.

(2) Nitrogen. The 400 brands of complete fertilizers contained nitrogen varying in amount from 0.30 to 8.08 per cent, and averaging 2.23 per cent. The average amount of nitrogen found by the Station analysis exceeded the average guaranteed amount by 0.14 per cent, the guaranteed average being 2.09 per cent and the average found being 2.23 per cent.

In 293 brands of complete fertilizers, the amount of nitrogen found was equal to or above the guaranteed amount, the excess varying from 0.01 to 2.73 per cent, and averaging 0.30 per cent.

In 107 brands, the nitrogen was below the guaranteed amount, the deficiency varying from 0.01 to 2.25 per cent and averaging 0.29 per cent. In 87 cases, the deficiency was less than 0.5 per cent.

The amount of water-soluble nitrogen varied from 0.01 to 6.25 per cent and averaged 0.95 per cent.

*Reprint of Bulletin No. 129.

(3) Available phosphoric acid. The 400 brands of complete fertilizers contained available phosphoric acid varying in amount from 0.83 to 19.68 per cent and averaging 8.44 per cent. The average amount of available phosphoric acid found by the Station analysis exceeded the average guaranteed amount by 0.81 per cent, the guaranteed average being 7.63 per cent and the average found being 8.44 per cent.

In 326 brands of complete fertilizers, the amount of available phosphoric acid found was above the amount guaranteed, the excess varying from 0.01 to 10.68 per cent and averaging 1.14 per cent.

In 74 brands, the available phosphoric acid was below the guaranteed amount, the deficiency varying from 0.01 to 3.06 per cent and averaging 0.58 per cent. In 49 cases the deficiency was below 0.5 per cent.

The amount of water-soluble phosphoric acid varied from 0 to 12.47 per cent and averaged 4.97 per cent.

(4) Potash. The complete fertilizers contained potash varying in amount from 0.08 to 15.58 per cent, and averaging 4.57 per cent. The average amount of potash found by the Station analysis exceeded the average guaranteed amount by 0.27 per cent, the guaranteed average being 4.30 per cent and the average found being 4.57 per cent.

In 297 brands of complete fertilizers, the amount of potash found was above the guaranteed amount, the excess varying from 0.01 to 4.41 per cent and averaging 0.53 per cent.

In 103 brands, the potash was below the guaranteed amount, the deficiency varying from 0.01 to 8.32 per cent and averaging 0.47 per cent. In 85 of these cases, the deficiency was less than 0.5 per cent.

In 88 cases among the 400 brands of complete fertilizers the potash was contained in the form of sulphate free from an excess of chlorides.

(5) The retail selling price of the complete fertilizers varied from \$15 to \$60 a ton and averaged \$28.92. The retail cost of the separate ingredients unmixed varied from \$1.80 to \$34.25 and averaged \$20.17, or \$8.75 less than the selling price.

INTRODUCTION.

NUMBER AND KINDS OF FERTILIZERS COLLECTED.

During the spring of 1897, we collected 735 samples of commercial fertilizers, representing 500 different brands. The tabulated statement below indicates the different classes included in the collection.

CLASSES OF FERTILIZERS COLLECTED.

Brands containing only phosphoric acid.	Brands containing only potash.	Brands containing nitrogen and phosphoric acid without potash.	Brands containing nitrogen and potash without phosphoric acid.	Brands containing phosphoric acid and potash without nitrogen.	Brands of complete fertilizers
31	3	33	1	32	400

From these figures it can be seen that 80 per cent of the commercial fertilizers offered for sale during the spring consisted of complete fertilizers. The remaining 20 per cent was distributed in nearly equal proportions between acid phosphates, bone and mixtures containing acid phosphate and potash.

COMPOSITION OF FERTILIZERS COLLECTED.

The tabulated statement below shows the average composition of the complete fertilizers collected during the spring, together with a comparison of the guaranteed composition and that found by analysis.

AVERAGE COMPOSITION OF COMPLETE FERTILIZERS COLLECTED.

	PER CENT GUARANTEED.			PER CENT FOUND.			Average per cent found above guarantee.
	Lowest.	Highest.	Average.	Lowest.	Highest.	Average.	
Nitrogen	0.40	8.78	2.09	0.30	8.08	2.23	0.14
Available phosphoric acid	1.93	11.00	7.63	0.83	19.68	8.44	0.81
Insoluble phosphoric acid	......	......	......	0.10	8.06	2.19	......
Potash	0.14	19.00	4.30	0.08	15.58	4.57	0.27
Water-soluble nitrogen	......	......	......	0.01	6.25	0.95	......
Water-soluble phosphoric acid	......	......	......	0.20	12.47	4.97	......

Comparison of Selling Price and Commercial Valuation.

Giving to the different constituents the values assigned in the schedule on page 356 for mixed fertilizers, 14 cents a pound for nitrogen, 5½ cents a pound for water-soluble phosphoric acid, 5 cents a pound for citrate-soluble phosphoric acid, 2 cents a pound for insoluble phosphoric acid, and 4½ cents a pound for potash, we can calculate the commercial valuation, or the price, at which the separate unmixed materials contained in one ton of fertilizer, having the composition indicated in the preceding table, could be purchased for cash at retail at the seaboard. Knowing the retail prices at which these goods were offered for sale, we can also readily estimate the difference between the actual selling price of the mixed goods and the retail cash cost of the unmixed materials; the difference covers the cost of mixing, freight, profits, etc. We present these data in the following table, including only complete fertilizers.

Commercial Valuation and Selling Price of Fertilizers.

Commercial Valuation of Complete Fertilizers.			Selling Price of One Ton of Complete Fertilizer.			Average increased cost of mixed materials over unmixed materials for one ton.
Lowest.	Highest.	Average.	Lowest.	Highest.	Average.	
$1 80	$34 25	$20 17	$15 00	$60 00	$28 92	$8 75

Cost of One Pound of Plant-Food in Mixed Fertilizers as Purchased by Consumers.

In the table following we present figures showing the lowest, highest and average cost to the purchaser of one pound of plant-food in different forms.

COST OF ONE POUND OF PLANT–FOOD TO CONSUMERS.

IN COMPLETE FERTILIZERS.	Lowest.	Highest.	Average.
	Cents.	Cents.	Cents.
Nitrogen	11.7	187	20.1
Available phosphoric acid	4.4	69.7	7.5
Potash	3.75	60	6.5

From the foregoing figures, it is seen that, to some farmers who purchased a very low-grade fertilizer at a high price, the cost of nitrogen was $1.87 a pound; the available phosphoric acid, 69.7 cents; and the potash, 60 cents. On the other hand, to those farmers who purchased plant-food most cheaply, each pound of nitrogen cost 11.7 cents; of available phosphoric acid, 4.4 cents; and of potash, 3¾ cents. Taking an average of all the mixed fertilizers, farmers paid 20.1 cents a pound for nitrogen, 7½ cents a pound for available phosphoric acid and 6½ cents a pound for potash.

These figures indicate that farmers should invariably avoid purchasing low-grade fertilizers, unless they are sure that the price is proportionately low, a condition which rarely accompanies the sale of such fertilizers. It also appears that, on an average, in purchasing mixed fertilizers, farmers are paying much more for their plant-food than they can secure it for in unmixed forms direct from manufacturers. Thus, while the average cost of one pound of nitrogen to the farmer is 20.1 cents in mixed goods, it can be purchased for 12 to 15 cents a pound. While available phosphoric acid is costing 7½ cents a pound in mixed goods, it can be purchased at less than 5 cents, and the same is true of potash.

TRADE-VALUES OF PLANT-FOOD IN RAW MATERIALS AND CHEMICALS, ADOPTED BY EXPERIMENT STATIONS.

The trade-values in the following schedule represent the average prices at which, in the six months preceding March, the respective ingredients, in the form of unmixed raw materials,

could be bought at retail for cash in our large markets, Boston, New York and Philadelphia. These prices also correspond to the average wholesale prices for the six months preceding March, plus about 20 per cent, in case of goods for which there are wholesale quotations.

TRADE-VALUES OF FERTILIZING INGREDIENTS IN RAW MATERIALS AND CHEMICALS, ADOPTED BY EXPERIMENT STATIONS.

	1897. Cts. per pound.
Nitrogen in ammonia salts	13½
Nitrogen in nitrates	14
Organic nitrogen in dry and fine-ground fish, meat and blood, and in high-grade mixed fertilizers	14
Organic nitrogen in cotton-seed meal and castor-pomace	12
Organic nitrogen in fine-ground bone and tankage	13½
Organic nitrogen in fine-ground medium bone and tankage	11
Organic nitrogen in medium bone and tankage	8
Organic nitrogen in coarser bone and tankage	3
Organic nitrogen in hair, horn-shavings and coarse fish-scraps	3
Phosphoric acid, soluble in water	5½
Phosphoric acid, soluble in ammonium citrate	5
Phosphoric acid in fine bone and tankage	5
Phosphoric acid in fine medium bone and tankage	4
Phosphoric acid in medium bone and tankage	2½
Phosphoric acid in coarser bone and tankage	2
Phosphoric acid in fine-ground fish, cotton-seed meal, castor-pomace and wood ashes	4½
Phosphoric acid, insoluble in ammonium citrate, in mixed fertilizers	2
Potash as high-grade sulphate, in forms free from muriates (chlorides), in ashes, etc	5
Potash in muriate	4½

COMMERCIAL VALUATION OF FERTILIZERS.

The commercial valuation of a fertilizer consists in estimating the approximate value or money-cost of the essential fertilizing constituents (nitrogen, phosphoric acid and potash) in one ton of fertilizer. This does not take into consideration cost of mix-

ing, of transportation, storage, commissions to agents and dealers, etc., but only the one item of retail cash cost, in the market, of unmixed raw materials.

SIMPLE RULE FOR CALCULATING THE APPROXIMATE COMMERCIAL VALUATION OF A FERTILIZER FROM THE RESULTS OF ANALYSIS.

Multiply the per cent of nitrogen by three and to the product add the per cent of available phosphoric acid and the per cent of potash. The total sum will express in dollars and cents the approximate commercial valuation of one ton (2,000 pounds) of the fertilizer.

Example.—A fertilizer contains 3.44 per cent of nitrogen, 6.15 per cent of available phosphoric acid and 9.89 per cent of potash.

3.44 (per cent nitrogen) multiplied by three equals	$10 32
6.15 (per cent available phosphoric acid) equals	6 15
9.89 (per cent potash) equals	9 89
Total	$26 36

LIST OF MANUFACTURERS WHO HAVE FILED STATEMENTS REQUIRED BY LAW.

Manufacturers to the number of 184 have filed with this Station the statement required by law. Of these there are 61 whose factories are located outside of New York State. These 184 manufacturers put on the market 1,728 different brands. Many of these brands are manufactured for special parties in other states, so that the number of different brands actually sold in this state is short of the total given above. Within the past two years it has become very common to have special goods made for local dealers which have a limited sale in the dealer's immediate locality. This method is becoming more and more common, and, of course, increases largely the number of brands made and sold.

NAMES AND ADDRESSES OF MANUFACTURERS.	Number of brands reported.
Acme Fertilizer Co., 62 William Street, New York City	7
American Reduction Co., 1516 Second Avenue, Pittsburg, Pa	4
Armour Fertilizer Works, 205 La Salle Street, Chicago, Ill	7
Edward J. Attwood, Andover, N. Y	7
Bachman & Co., Chester, Orange Co., N. Y	1
A. M. Baker & Son, Mt. Morris, N. Y	6
H. J. Baker & Bro., 93 William Street, New York City	43
Addison Baldridge, MacDougall, N. Y	1
J. A. Bingham, Marlborough, N. Y	5
Bowker Fertilizer Co., 43 Chatham Street, Boston, Mass	40
Bradley Fertilizer Co., 92 State Street, Boston, Mass	39
The Bradley Fertilizer Co., Philadelphia, Pa	13
Brisbin & Douglas, Clyde, N. Y	2
Charles Brown, Mt. Morris, N. Y	1
Brumfield & Foster, Colora, Md	9
J. P. Butts, Oneonta, N. Y	4
Chandler, Russell & Chandler, Newark, N. J	9
E. B. Chapin, Rochester, N. Y	3
R. F. Chappius, Dryden, N. Y	1
Chemical Co. of Canton, Baltimore, Md	11
Chesapeake Guano Co., Baltimore, Md	3
Clark & Powers, Fabius, N. Y	1
Clark's Cove Fertilizer Co., 40 Exchange Place, New York City	15
The Cleveland Dryer Co., 92 State Street, Boston, Mass	8
Club and Grange Fertilizer Co., Syracuse, N. Y	6
E. Frank Coe Co., 135 Front street, New York city	28
Colgrove & Vann, Willow Creek, N. Y	2
Peter Cooper's Glue Factory, 13 Burling slip, New York City	1
A. S. Core Fertilizer Works, White Plains, N. Y	14
Crocker Fertilizer and Chemical Co., Buffalo, N. Y	242
E. A. Cross, Hilton, N. Y	3
Cuba Fertilizer Co., Cuba, N. Y	9
Cumberland Bone Phosphate Co., Portland, Me	12
Cuyler & Carr, Milford, N. Y	4
L. B. Darling Fertilizer Co., Pawtucket, R. I	10
Detrick Fertilizer and Chemical Co., Baltimore, Md	27
Louis F. Detrick, Baltimore, Md	9
C. A. Dryer, South Lima, N. Y	3
P. P. Dunan, 310 Equitable Building, Baltimore, Md	8
Edward Dwyer, Livonia, N. Y	3
Eastern Farm Supply Association, Montclair, N. J	12
Robert D. Eaton, Norwich, N. Y	6

NAMES AND ADDRESSES OF MANUFACTURERS.	Number of brands reported.
The Elixir Fertilizer Co., 107 W. 14th Street, New York City	1
Erie City Fertilizer Works, Erie, Pa	4
Essex Fertilizer Co., Newark, N. J	2
Geo. S. Ewart, North Sparta, N. Y	1
Farmers' Fertilizer Co., Syracuse, N. Y	14
Farmers' and Builders' Supply Co., Owego, N. Y	7
W. S. Farmer & Co., Baltimore, Md	6
John Finster, Rome, N. Y	1
Henry Fitchard, Minetto, N. Y	1
Geo. B. Forrester, 169 Front Street, New York City	19
Thos. P. Gaines, Sherburne, N. Y	3
Geneva Coal Co., Geneva, N. Y	15
A. C. Geslain, 131 Rutledge Street, Brooklyn, N. Y	2
G. W. Goddard, Mt. Upton, N. Y	3
Great Eastern Fertilizer Co., Rutland, Vt	16
Griffith & Boyd, 9 South Gay Street, Baltimore, Md	9
John Haefele, Delaware Avenue, Albany, N. Y	1
H. O. Hale, Norwich, N. Y	3
Ira C. Hall, Farmer, N. Y	5
The Hallock and Duryee Fertilizer Co., Mattituck, N. Y	5
Hammond's Paint and Slug-Shot Works, Fishkill, N. Y	1
John Hardiman, New Hartford, N. Y	2
Geo. L. Harding, 205 Water Street, Binghamton, N. Y	1
Hathaway & Reynolds, Oriskany Falls, N. Y	5
Isaac C. Hendrickson, Jamaica, N. Y	2
S. M. Hess & Bro., 4th and Chestnut Streets, Philadelphia, Pa	9
J. S. Hewitt & Sons, Locke, N. Y	8
C. C. Hicks, Penn Yan, N. Y	9
Hubbard & Co., 10 Light Street, Baltimore, Md	9
Humphrey & Holdridge, Honeoye Falls, N. Y	6
Imperial Fertilizer Co., 5 Hanover Street, New York City	2
International Seed Co., Rochester, N. Y	3
Geo. A. Ives, Bainbridge, N. Y	2
F. N. Isham, Avon, N. Y	1
The Jarecki Chemical Co., Sandusky, Ohio	8
The Jones Fertilizer Co., Cincinnati, Ohio	9
F. W. Jones, Jonesburg, N. Y	4
Kinne Bros. & Howell, Ovid, N. Y	1
Lackawanna Fertilizer and Chemical Co., Moosic, Pa	4
F. R. Lalor, Dunnville, Ontario, Can	1
Lazaretto Guano Co., Baltimore, Md	45

NAMES AND ADDRESSES OF MANUFACTURERS.	Number of brands reported.
Liebig Manufacturing Co., 26 Broadway, New York City	10
Lister Agricultural Chemical Works, Newark, N. J	27
Joseph Lister, 1158 Elston Avenue, Chicago, Ill	1
Locke Fertilizer Co., Locke, N. Y	8
Lonergan & Livingston, Albany, N. Y	2
Long Island Agricultural Chemical Co., Long Island City, N. Y	6
George F. Lowe, LeRoy, N. Y	1
Lowell Fertilizer Co., Lowell, Mass	11
Frederick Ludlam, 108 Water Street, New York City	8
Mapes Formula and Peruvian Guano Co., 143 Liberty Street, New York City	18
Maryland Fertilizing and Manufacturing Co., 30 South Halliday Street, Baltimore, Md	19
Maxson & Starin, Cortland, N. Y	12
W. B. McDowell, Middletown, N. Y	2
Michigan Carbon Works, Detroit, Mich	9
Miller Fertilizer Co., 411 East Pratt Street, Baltimore, Md	7
Milsom Rendering and Fertilizer Co., East Buffalo, N. Y	20
Minot & Decker, Brockport, N. Y	4
Mitchell Fertilizer Co., Tremley, N. J	3
L. Mittenmaier & Son, Rome, N. Y	4
Moller & Co., Maspeth, N. Y	2
Francis P. Murray, Macedon, N. Y	2
National Fertilizer Co., Bridgeport, N. Y	6
Geo. A. Newcomb, Cottage, N. Y	1
Wm. Newton, Henrietta, N. Y	1
New York Fertilizer Co., 203 Broadway, New York City	1
Niagara Fertilizer Works, Buffalo, N. Y	38
Northwestern Fertilizing Co., Chicago, Ill	18
Oakfield Fertilizer Co., Buffalo, N. Y	8
Oneonta Fertilizer and Chemical Co., Oneonta, N. Y	18
Overton & Co., Reading Center, N. Y	1
Pacific Guano Co., 27 William Street, New York City	23
Packers' Union Fertilizer Co., New York City	7
Chas. D. Parks, Danbury, Conn	3
Patapsco Guano Co., Baltimore, Md	21
G. A. Pearsall, Williamson, N. Y	5
E. E. Pease, Mapleton, N. Y	1
Penfield Milling Co., Delhi, N. Y	2
A. W. Perkins & Co., Rutland, Vt	1
A. Peterson, Penfield, N. Y	5

Names and Addresses of Manufacturers.	Number of brands reported.
J. E. Phelps, Jamaica, N. Y	7
Moro Phillips Chemical Co., 131 South 3d Street, Philadelphia, Pa	17
Wm. W. Phipps, Albion, N. Y	4
H. A. Pierce & Co., Armor, N. Y	2
B. J. Pine, East Williston, N. Y	1
L. S. Pitkin, Lorraine, N. Y	1
Powers, Gibbs & Co., Wilmington, N. C	10
Preston Fertilizer Co., Long Island City, N. Y	16
Queen City Fertilizer Co., Buffalo, N. Y	15
Quinnipiac Co., 83 Fulton Street, New York City	38
Rasin Fertilizer Co., Baltimore, Md	9
Read Fertilizer Co., 88 Wall Street, New York City	35
John S. Reese & Co., Baltimore, Md	20
J. L. Reynolds & Co., Mt. Vernon, N. Y	3
C. A. Rice, Ellington, N. Y	1
J. L. Richer, New Berlin, N. Y	2
Riverside Acid Works, Warren, Pa	4
Rochester Fertilizer Works, Rochester, N. Y	17
Rogers & Hubbard Co., Middletown, Conn	10
Sessions & Leonard, Palmyra, N. Y	4
Shappee Bros., Horseheads, N. Y	1
Sharpless & Carpenter, 24 South Delaware Avenue, Philadelphia, Pa.	13
G. W. Sharretts & Co., 8th Street and 2d Avenue, Baltimore, Md	6
Chas. A. Sickler & Bro., Wilkesbarre, Pa	5
Isaac Smith, Columbiaville, N. Y	7
Spaulding & Conde, Lyndonville, N. Y	1
W. W. Sprague Co., Union Stock Yards, Chicago, Ill	1
W. H. Stamp, Warsaw, N. Y	6
H. Stappenbeck, Utica, N. Y	3
Standard Fertilizer Co., Boston, Mass	18
Sterling Oil Co., Greenport, N. Y	1
G. W. Stoddard, Mt. Upton, N. Y	3
W. B. Stewart, South Plymouth, N. Y	3
Swift & Co., Chicago, Ill	6
C. R. Sworts, Dundee, N. Y	7
F. W. Tassell, Williamson, N. Y	2
I. P. Thomas & Son, 2 South Delaware Avenue, Philadelphia, Pa	13
Edward D. Tolles, Attica, N. Y	8
Henry F. Tucker Co., Boston, Mass	3
Geo. O. P. Turner, Churchville, N. Y	8
Ellsworth Tuthill & Co., Promised Land, N. Y	6

Names and Addresses of Manufacturers.	Number of brands reported.
George F. Tuthill & Co., Greenport, N. Y.	1
J. E. Tygert & Co., 42 South Delaware Avenue, Philadelphia, Pa.	8
Tygert-Allen Fertilizer Co., 2 Chestnut Street, Philadelphia, Pa.	9
F. G. Underwood, Oneida, N. Y.	3
J. E. Van Benthuysen, Lishaskill, N. Y.	4
J. W. VanCott & Son, Unadilla, N. Y.	3
Walker Fertilizer Co., Clifton Springs, N. Y.	16
Walker, Stratman & Co., Pittsburg, Pa.	8
F. E. Webster, Sennett, N. Y.	1
Robt. West, Hamilton, Ontario, Can.	2
W. E. Whann, William Penn, Pa.	8
M. E. Wheeler & Co., Rutland, Vt.	10
Wickwire & Sheldon, Hamilton, N. Y.	4
Willoughby & Fletcher, Oxford, N. Y.	2
Wilkinson & Co., 29 South William Street, New York City	2
Williams & Clark Fertilizer Co., 27 William Street, New York City	25
M. J. Wilson, Rushford, N. Y.	1
Wooster & Mott, Union Hill, N. Y.	7
C. K. Yates, Farmer, N. Y.	1
York Chemical Works, York, Pa.	5
Zell Guano Co., Baltimore, Md.	45

TERMS USED IN STATING RESULTS OF ANALYSIS.

In the tables following, the terms used to express the results of analysis are self-explanatory for the most part. Attention is called, however, to two additional determinations which we have not usually published heretofore.

One of these is "water-soluble" phosphoric acid. While manufacturers are required to guarantee only the amount of available phosphoric acid (water-soluble plus reverted or citrate-soluble), yet it seems desirable that consumers should know what proportion of the available is water-soluble. The available phosphoric acid being equal, one would choose by preference a fertilizer containing the larger amount of water-soluble phosphoric acid.

The amount of water-soluble phosphoric acid varied from 0 to 12.47 per cent and averaged 4.97 per cent. This constituted nearly 60 per cent of the available phosphoric acid present.

The water-soluble nitrogen includes nitrogen present in the form of ammonia salts and nitrates together with that present in small amounts of soluble organic matter. The amount of water-soluble nitrogen varied from 0.01 to 6.25 per cent and averaged 0.95 per cent. This constituted 42.6 per cent of the total nitrogen present.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
W. W. Acheson, Belleview, Fla.	Animal food for vegetable, field and fruit crops.	Albany.	3447
Acme Fertilizer Co., Maspeth, N. Y.	Acme fertilizer No. 1.	Jamaica.	3074
Acme Fertilizer Co., Maspeth, N. Y.	Acme fertilizer No. 2.	Jamaica.	3067
Acme Fertilizer Co., Maspeth, N. Y.	High grade special.	Jamaica.	3075
Acme Fertilizer Co., Maspeth, N. Y.	Superior superphosphate.	Bridgehampton.	3142
Allison & Co., New York City.	Canada hard wood ashes.	East Marion.	3114
American Reduction Co., Pittsburg, Pa.	Powter's brand.	Otto.	3283
American Reduction Co., Pittsburg, Pa.	Powter's general phosphate.	Otto.	3281
American Reduction Co., Pittsburg, Pa.	Special potato.	Otto.	3282
The Armour Fertilizer Works, Chicago, Ill.	All soluble.	Bliss.	3367
The Armour Fertilizer Works, Chicago, Ill.	Blood and bone.	Bliss.	3366

lected in New York State During the Spring of 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	———	———	13.50	0.50	———	———
Found			19.60	0.04		
Below guarantee				0.46		
Guaranteed	3.70	8	———	9	———	———
Found	3.45	6.60	8.68	8.77*	2.63	1.93
Below guarantee	0.25	1.40		0.23		
Guaranteed	4.95	8	———	5	———	———
Found	4.59	7.03	9.11	4.92	2.71	1.99
Below guarantee	0.36	0.97				
Guaranteed	7.40	7	———	4	———	———
Found	6.18	5.97	8.54	4.63	4.35	2.14
Below guarantee	1.22	1.03				
Guaranteed	1.23	6	———	4	———	———
Found	1.58	8.97	12.01	5.01*	0.68	2.37
Guaranteed	———	———	1.50	5	———	———
Found			0.47	3.70		
Below guarantee			1.03	1.30		
Guaranteed	1.20	8	———	1.50	———	———
Found	1.80	5.41	8.73	2.29*	0.49	2.37
Below guarantee		2.59				
Guaranteed	1.60	8	———	2	———	———
Found	2.18	4.94	8.99	2.14*	0.63	2.47
Below guarantee		3.02				
Guaranteed	2.50	———	2	7	———	———
Found	1.99	1.09	1.37	9.88*	0.29	0.33
Below guarantee	0.51		0.63			
Guaranteed	2.88	8	10	4	———	———
Found	2.88	7.05	9.96	5.95*	1.76	2.55
Below guarantee		0.95				
Guaranteed	5.76	———	10	———	———	———
Found	6.78		10.26		5.52	

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
The Armour Fertilizer Works, Chicago, Ill.	Bone, blood and potash.	Batavia.	3347
The Armour Fertilizer Works, Chicago, Ill.	Grain grower.	Batavia.	3346
E. J. Attwood, Andover, N. Y.	New York standard No. 2.	Andover.	3384
Bachman & Co., Chester, N. Y.	Success.	Chester.	3194
A. M. Baker & Son, Mt. Morris, N. Y.	Ontario.	Mt. Morris.	3386
H. J. Baker & Bro., New York City.	Complete cabbage manure.	Jamaica.	3072
H. J. Baker & Bro., New York City.	Complete nitrogenized manure.	Jamaica.	3073
H. J. Baker & Bro., New York City.	Complete potato manure.	Jamaica. Poughkeepsie.	3071 3173
H. J. Baker & Bro., New York City.	Harvest home.	Poughkeepsie.	3172
H. J. Baker & Bro., New York City.	Lawn dressing.	White Plains.	3160
H. J. Baker & Bro., New York City.	Standard UNXLD.	Poughkeepsie. Glens Falls.	3171 3394

LECTED IN NEW YORK STATE DURING THE SPRING OF 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	4.11	8	10	7	—	—
Found	4.41	9.17	13.12	7.11*	1.02	6.03
Guaranteed	1.64	8	10	2	—	—
Found	2.37	8.33	13.49	2.02	0.52	5.31
Guaranteed	1.23	10	—	3	—	—
Found	1.26	9.97	11.19	3.07	0.71	7.34
Guaranteed	1.15	1.93	6.78	0.14	—	—
Found	0.30	0.83	0.96	0.08	0.04	
Below guarantee	0.85	1.10				
Guaranteed	1.03	10	—	4	—	—
Found	1.37	10.22	13.44	4.29	0.29	6.94
Guaranteed	4.75	5	6	7	—	—
Found	4.87	6.30	6.66	6.96*	3.05	4.80
Guaranteed	8	5	6	3	—	—
Found	7.70	6.22	6.61	4.06*	3.93	4.23
Below guarantee	0.30					
Guaranteed	3.30	5.75	6.75	10	—	—
Found	3.78	6.56	6.93	10.17*	1.86	5.38
Guaranteed	1.25	8	—	2	—	—
Found	1.55	8.87	10.37	2.68	0.54	5.44
Guaranteed	3.70	5	6	7.50	—	—
Found	3.66	6.30	6.87	7.49	2.34	3.77
Guaranteed	1.85	8	9	2.25	—	—
Found	2.38	10	11.18	3.41	1.01	3.56

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
H. J. Baker & Bro., New York City.	Vegetable, vine and potato manure.	Kingston.	3209
H. J. Baker & Bro., New York City.	Victor.	Cutchogue.	3128
Becker Bros., Gowanda, N. Y.	Erie County special.	Gowanda.	3324
Becker Bros., Gowanda, N. Y.	Ohio Valley.	Gowanda.	3325
Becker Bros., Gowanda, N. Y.	Potato special.	Gowanda.	3326
Bowker Fertilizer Co., Boston, Mass.	Ammoniated dissolved bone.	Jamaica. Silver Creek. Lansingburgh.	3100 3255 3424
Bowker Fertilizer Co., Boston, Mass.	C. A. D. special No. 2.	South Lima.	3583
Bowker Fertilizer Co., Boston, Mass.	C. A. D. special No. 3.	South Lima.	3582
Bowker Fertilizer Co., Boston, Mass.	Corn phosphate.	Lishaskill.	3475
Bowker Fertilizer Co., Boston, Mass.	Dissolved bone phosphate.	Brocton.	3245
Bowker Fertilizer Co., Boston, Mass.	Empire State bone and potash.	Collins.	3323

lected in New York State During the Spring of 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	1.65	5	6	12	—	—
Found	1.96	6.56	6.68	11.28	0.81	5.30
Below guarantee				0.72		
Guaranteed	3	10	—	8	—	—
Found	3.40	10.33	11.32	8.34	1.90	7.87
Guaranteed	1.64	7	—	2	—	—
Found	1.65	8.34	11.19	1.37	0.09	5.44
Below guarantee				0.63		
Guaranteed	1.64	8	—	2	—	—
Found	2.10	8.16	10.80	2.05	0.09	4.94
Guaranteed	3.28	9	—	5	—	—
Found	3.15	10.37	11.55	5.14	0.36	8.51
Guaranteed	1.50	8	10	2	—	—
Found	1.64	8.10	12.19	2.23	0.43	4.96
Guaranteed	0.75	7	8	12	—	—
Found	0.79	9.71	11.66	10.20	0.53	5.54
Below guarantee				1.80		
Guaranteed	2.25	8	9	15	—	—
Found	2.51	7.04	10.18	15.58	1.35	1.88
Below guarantee		0.96				
Guaranteed	1.50	9	11	2	—	—
Found	1.84	8.76	12.02	2.23	0.51	3.94
Below guarantee		0.24				
Guaranteed	—	11	13	—	—	—
Found		10.88	15.28			5.67
Guaranteed	—	8	10	3	—	—
Found		8.74	12.41	3.76		4.82

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Bowker Fertilizer Co., Boston, Mass.	Farm and garden phosphate.	Gloversville. Camden.	3503 3753
Bowker Fertilizer Co., Boston, Mass.	Fine dry ground fish.	Jamaica.	3099
Bowker Fertilizer Co., Boston, Mass.	Fresh ground bone.	Lansingburgh. Oswego.	3423 3701
Bowker Fertilizer Co., Boston, Mass.	Fresh milled kainit.	Lishaskill.	3476
Bowker Fertilizer Co., Boston, Mass.	Grape belt and fruit special with extra potash.	North Collins.	3333
Bowker Fertilizer Co., Boston, Mass.	Harvest bone dissolved.	Warsaw.	3370
Bowker Fertilizer Co., Boston, Mass.	Hill and drill.	Orient. Silver Creek. Glens Falls.	3115 3253 3395
Bowker Fertilizer Co., Boston, Mass.	Hop and potato phosphate with extra potash.	Glens Falls. North Collins. Cortland.	3397 3332 3634
Bowker Fertilizer Co., Boston, Mass.	Lawn and garden.	West Troy. Binghamton.	3440 3594
Bowker Fertilizer Co., Boston, Mass.	Market bone.	Southampton. Cooperstown.	3156 3574
Bowker Fertilizer Co., Boston, Mass.	Market garden fertilizer.	Orient.	3116

LECTED IN NEW YORK STATE DURING THE SPRING OF 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	1.50	8	10	2	——	——
Found	1.87	9.45	11.66	2.25	0.80	6.55
Guaranteed	6.60	——	6	——	——	——
Found	6.21		5.89		0.40	0.57
Below guarantee	0.39					
Guaranteed	2.50	5	18	——	——	——
Found	2.53	10.44	20.64		0.91	0.78
Guaranteed	——	——	——	11	——	——
Found				11.49		
Guaranteed	0.80	7	——	5	——	——
Found	0.73	8.60	11.43	8.40	0.01	4.47
Guaranteed	——	12	——	——	——	——
Found		14.37	17.14			7.42
Guaranteed	2.25	9	12	2	——	——
Found	2.81	9.15	12.13	2.44	1.61	5.28
Guaranteed	0.82	8	10	5	——	——
Found	1.06	8.29	11.77	5.82	0.53	3.05
Guaranteed	3.25	6	8	5	——	——
Found	4.71	6.90	10.22	4.91	3.81	0.27
Guaranteed	1.50	——	16	——	——	——
Found	1.94		23.86		0.70	0.89
Guaranteed	2.25	6	8	10	——	——
Found	2.72	8.21	10.37	10.15	0.98	5.23

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Bowker Fertilizer Co., Boston, Mass.	Potash bone.	Brocton.	3244
Bowker Fertilizer Co., Boston, Mass.	Potash phosphate.	Lishaskill. Collins. Camden.	3477 3322 3752
Bowker Fertilizer Co., Boston, Mass.	Potato manure.	Southampton.	3155
Bowker Fertilizer Co., Boston, Mass.	Potato phosphate.	Brocton. West Troy. Gloversville.	3243 3438 3504
Bowker Fertilizer Co., Boston, Mass.	Special formula.	Fenton.	3338
Bowker Fertilizer Co., Boston, Mass.	Staple phosphate.	Springville. Oswego.	3317 3702
Bowker Fertilizer Co., Boston, Mass.	Stockbridge cabbage and cauliflower manure.	West Troy.	3439
Bowker Fertilizer Co., Boston, Mass.	Stockbridge celery special.	West Troy.	3441
Bowker Fertilizer Co., Boston, Mass.	Stockbridge corn, grain, etc.	Albany.	3445
Bowker Fertilizer Co., Boston, Mass.	Stockbridge manure.	Glens Falls.	3396
Bowker Fertilizer Co., Boston, Mass.	Stockbridge onion special.	West Troy.	3442

LECTED IN NEW YORK STATE DURING THE SPRING OF 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	0.75	5	7	2	——	——
Found	1.14	9.46	12.01	2.74	0.55	6.22
Guaranteed	0.75	8	10	3	——	——
Found	1.01	8.23	11.93	3.88	0.46	2.82
Guaranteed	2.25	8	10	4	——	——
Found	2.78	9.37	11.45	4.24	0.78	6.25
Guaranteed	1.50	8	10	2	——	——
Found	1.71	9.08	11.98	2.25	0.58	1.31
Guaranteed	2	10	——	8	——	——
Found	1.37	11.57	12.19	6.57*		8.89
Below guarantee	0.63			1.43		
Guaranteed	0.75	8	——	3	——	——
Found	0.89	10.22	12.33	3.35	0.25	5.09
Guaranteed	4	5	6	6	——	——
Found	5.03	5.08	8.08	6.71	3.66	2.77
Guaranteed	4.10	4	5	5.50	——	——
Found	5	6.64	8.44	7.04	3.01	5.45
Guaranteed	3.25	8	10	4	——	——
Found	3.27	9.53	11.58	4.63	1.38	7.32
Guaranteed	3.25	5	8	10	——	——
Found	3	4.56	10.45	9.99	1.55	1.13
Below guarantee	0.25	0.44				
Guaranteed	4.50	6	8	5	——	——
Found	4.30	7.95	9.70	7.33	2.27	5.50

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Bowker Fertilizer Co., Boston, Mass.	Stockbridge potato and vegetable manure.	Southampton.	3154
Bowker Fertilizer Co., Boston, Mass.	Stockbridge vegetable and potato manure.	Troy.	3427
Bowker Fertilizer Co., Boston, Mass.	Stockbridge top dressing.	Southampton.	3153
Bowker Fertilizer Co., Boston, Mass.	Superphosphate.	Lishaskill. Oswego.	3474 3703
Bowker Fertilizer Co., Boston, Mass.	Superphosphate with potash.	Cattaraugus. Lansingburgh. Cortland.	3280 3426 3633
Bowker Fertilizer Co., Boston, Mass.	Sure crop.	Silver Creek. Lansingburgh. Seneca Hill.	3254 3425 3698
Bowker Fertilizer Co., Boston, Mass.	Tobacco grower.	Syracuse.	3674
Bowker Fertilizer Co., Boston, Mass.	Tobacco phosphate.	Syracuse.	3675
Bowker Fertilizer Co., Boston, Mass.	Wells & Hudson's high-grade.	Riverhead.	3132
Bradley Fertilizer Co., Boston, Mass.	Ammoniated dissolved bones.	Glens Falls. Tully.	3407 3649
Bradley Fertilizer Co., Boston, Mass.	Bean and potato phosphate.	Glens Falls. Tully.	3405 3650

LECTED IN NEW YORK STATE DURING THE SPRING OF 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	3.25	5	8	10	——	——
Found	3.38	7.28	8.77	10.52	1.25	3.58
Guaranteed	3.25	6	8	7	——	——
Found	3.28	9.37	12.25	6.46	1.79	5.78
Below guarantee				0.54		
Guaranteed	5	4	6	6	——	——
Found	5.20	7.84	8.92	7.34	3.37	4.61
Guaranteed	——	13	15	——	——	——
Found		11.88	16.04			7.11
Below guarantee		1.12				
Guaranteed	——	10	12	1	——	——
Found		14.96	16.93	1.47		10.40
Guaranteed	0.75	8	——	1	——	——
Found	1.19	9.29	11.77	1.70	1.52	5.59
Guaranteed	2.25	7	——	4	——	——
Found	2.63	9.63	10.61	3.93	1.74	5.20
Guaranteed	1.25	8.50	——	1.08	——	——
Found	1.45	9.64	11.42	1.18	0.48	7.09
Guaranteed	3.30	7	9	7	——	——
Found	3.42	8.51	10.95	7.54	1	5.44
Guaranteed	1.65	7	8	1	——	——
Found	2.23	7.91	11.09	1.67	0.81	3.86
Guaranteed	0.82	8	10	3.25	——	——
Found	1.44	7.31	9.94	3.32	0.41	5.21
Below guarantee		0.69				

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Bradley Fertilizer Co., Boston, Mass.	B D sea fowl guano.	Attica. Amsterdam. Canton.	3352 3484 3781
Bradley Fertilizer Co., Boston, Mass.	Complete manure for potatoes and vegetables.	Jamaica. Troy.	3079 3443
Bradley Fertilizer Co., Boston, Mass.	Farmers' new method.	Cornwall. Evans. Albany.	3189 3277 3448
Bradley Fertilizer Co., Boston, Mass.	Hop fertilizer.	Solsville.	3546
Bradley Fertilizer Co., Boston, Mass.	Niagara phosphate.	Evans. Glens Falls. Tully.	3276 3406 3651
Bradley Fertilizer Co., Boston, Mass.	Patent superphosphate.	Troy. Tully.	3436 3646
Bradley Fertilizer Co., Boston, Mass.	Potato fertilizer.	Cornwall. Troy. Tully	3188 3435 3647
Brumfield & Foster, Colora, Md.	Hard-times ammoniated phosphate.	Sherburne.	3531
Brumfield & Foster, Colora, Md.	High-grade acid phosphate.	Sherburne.	3530
J. P. Butts, Oneonta, N. Y.	Hustler.	Oneonta.	3567
Cuyler E. Carr, Milford, N. Y.	Potato and hop fertilizer.	Milford.	3576

LECTED IN NEW YORK STATE DURING THE SPRING OF 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pound of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	2.06	8	10	1.50	——	——
Found	2.29	8.45	10.25	2.12	0.66	6.19
Guaranteed	3.71	8.50	10	7	——	——
Found	3.63	8.91	10.66	7.44	1	4.82
Guaranteed	0.82	8	10	2.15	——	——
Found	1.30	8.28	10.37	2.13	0.36	4.45
Guaranteed	1.65	8	9	4.32	——	——
Found	2.06	9.34	11.71	4.70	0.64	5.13
Guaranteed	0.82	7	8	1.08	——	——
Found	1.20	8.19	9.95	1.60	0.33	5.91
Guaranteed	2.06	8	10	1.50	——	——
Found	2.29	9.81	12.57	1.57	0.72	4.69
Guaranteed	2.06	9	11	3.25	——	——
Found	3	9.59	12.28	3.47	1.12	4.00
Guaranteed	0.80	10	11	1	——	——
Found	1.31	12.84	14.03	0.88	0.74	0.84
Guaranteed	——	14	——	——	——	——
Found		16.05	17.04			8.22
Guaranteed	0.82	8	——	4	——	——
Found	0.87	9.01	10.60	3.92	0.53	6.39
Guaranteed	0.82	8	——	4	——	——
Found	0.91	8.81	10.30	3.77	0.43	6.43
Below guarantee				0.23		

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Chandler, Russell & Chandler, Newark, N. J.	Potato manure.	Jamaica.	3066
E. B. Chapin, Rochester, N. Y.	Monroe chief.	Rochester.	3787
E. B. Chapin, Rochester, N. Y.	Potato fertilizer.	Rochester.	3788
E. B. Chapin, Rochester, N. Y.	Standard.	Rochester.	3588
Chesapeake Guano Co., Baltimore, Md.	Ammoniated bone superphosphate.	North Collins.	3335
Chesapeake Guano Co., Baltimore, Md.	New York special No. 2.	North Collins.	3334
Clark's Cove Fertilizer Co., New York City.	Bay State fertilizer.	Gloversville.	3505
Clark's Cove Fertilizer Co., New York City.	Defiance complete manure.	Lishaskill. Pulaski.	3473 3724
Clark's Cove Fertilizer Co., New York City.	Good acre hop and tobacco grower.	Lishaskill.	3471
Clark's Cove Fertilizer Co., New York City.	King Philip alkaline guano.	Lishaskill. Pulaski.	3469 3725
Clark's Cove Fertilizer Co., New York City.	Potato phosphate.	Lishaskill.	3470

lected in New York State During the Spring of 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	3.70	7.50	———	7	———	———
Found	3.51	8.64	9.63	7.44	2.47	5.47
Guaranteed	1.25	6	———	4	———	———
Found	1.35	6.21	8.89	4.40*	0.45	2.39
Guaranteed	1.25	7	———	6	———	———
Found	1.03	5.74	7.80	5.59	0.29	2.70
Below guarantee	0.22	1.26		0.41		
Guaranteed	1.75	7	———	3	———	———
Found	1.52	6.49	9.41	4.23*	0.39	2.52
Below guarantee	0.23	0.51				
Guaranteed	0.82	8	9	1	———	———
Found	1.33	9.15	12.85	1.15	0.81	3
Guaranteed	1.65	8	———	2	———	———
Found	1.86	8.21	10.08	2.18	1.13	6.25
Guaranteed	2.47	9	———	2	———	———
Found	1.30	7.44	10.80	3.24	0.45	1.66
Below guarantee	1.17	1.56				
Guaranteed	0.82	6	8	2	———	———
Found	1.50	8.71	11.77	2.09	0.51	2.38
Guaranteed	2.10	8	9	3	———	———
Found	2.15	9.81	13.44	3.09	0.45	3.16
Guaranteed	1.25	6	7	3	———	———
Found	1.50	6.38	9.34	2.96	0.39	1.97
Guaranteed	2.47	6	7	5	———	———
Found	2.78	7.27	9.05	5.17	0.75	4.70

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Clark's Cove Fertilizer Co., New York City.	Soverign acid phosphate.	Altamont.	3581
Clark's Cove Fertilizer Co., New York City.	Sunflower bone meal.	Lishaskill.	3478
Clark's Cove Fertilizer Co., New York City.	Sweepstakes potato manure.	Lishaskill.	3472
Cleveland Dryer Co., Cleveland, Ohio.	Buckeye ammoniated bone superphosphate.	Jamestown.	3222
Cleveland Dryer Co., Cleveland, Ohio.	Horsehead phosphate.	Jamestown.	3220
Cleveland Dryer Co., Cleveland, Ohio.	Phospho bone.	Jamestown.	3221
Cleveland Dryer Co., Cleveland, Ohio.	Superior bone.	North Collins.	3337
Club & Grange Fertilizer Co., Syracuse, N. Y.	No. 1.	Sidney. E. Syracuse.	3550 3673
Club & Grange Fertilizer Co., Syracuse, N. Y.	No. 2.	E. Syracuse.	3672
E. Frank Coe Co., New York City.	Ammoniated bone superphosphate.	Redwood.	3773
E. Frank Coe Co., New York City.	Buckwheat fertilizer.	Ellicottville. De Ruyter.	3299 3636

LECTED IN NEW YORK STATE DURING THE SPRING OF 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	—	12	13	—	—	—
Found		14.92	15.84			11.64
Guaranteed	1.65	—	14	—	—	—
Found	2.22		19.92		0.43	
Guaranteed	2.88	7	8	7.50	—	—
Found	2.96	7.18	10.16	7.49	1.49	1.59
Guaranteed	2.47	9	11	1	—	—
Found	1.64	9.64	13.52	0.35*	0.91	5.69
Below guarantee	0.83			0.65		
Guaranteed	—	10	12	—	—	—
Found		12.56	14.18			8.66
Guaranteed	2.60	10	—	1.08	—	—
Found	0.90	8.35	12.51	0.73*	0.18	4.50
Below guarantee	1.70	1.65		0.35		
Guaranteed	3.29	—	22	—	—	—
Found	3.14		20.75		0.85	
Below guarantee			1.25			
Guaranteed	—	8	10	3	—	—
Found		9.43	10.43	2.90		3.15
Guaranteed	1.65	8	9	2	—	—
Found	0.90	8.11	10.51	1.69*	0.08	3.41
Below guarantee	0.75			0.31		
Guaranteed	2	9	—	1.35	—	—
Found	1.99	9.43	12.32	1.8 *	0.70	6.09
Guaranteed	0.40	9.50	11	1	—	—
Found	0.61	9.37	13.41	1.07*	0.11	6.11

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
E. Frank Coe Co., New York City.	Celebrated special potato fertilizer.	Newburg. Troy.	3182 3428
E. Frank Coe Co., New York City.	Columbian brand ammoniated bone superphosphate.	Poughkeepsie.	3174
E. Frank Coe Co., New York City.	Columbian corn fertilizer.	Ellicottville. De Ruyter. Redwood.	3303 3637 3775
E. Frank Coe Co., New York City.	Columbian potato fertilizer.	Poughkeepsie. De Ruyter.	3175 3635
E. Frank Coe Co., New York City.	Dissolved bone potash	Varysburg.	3372
E. Frank Coe Co., New York City.	Excelsior guano.	Jamaica.	3081
E. Frank Coe Co., New York City.	Gold brand.	Homer.	3640
E. Frank Coe Co., New York City.	Grain fertilizer.	De Ruyter.	3638
E. Frank Coe Co., New York City.	High grade soluble bone.	Ellicottville. Nelson.	3302 3742
E. Frank Coe Co., New York City.	High grade special corn fertilizer.	Newburg.	3183
E. Frank Coe Co., New York City.	Matchless grain fertilizer.	Newburg. Ellicottville.	3184 3304

LECTED IN NEW YORK STATE DURING THE SPRING OF 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	1.65	9	11	3.50	——	——
Found	1.74	9.48	12.59	3.59*	0.88	6.88
Guaranteed	1	9	11	1.85	——	——
Found	1.76	9.29	12.44	2.01*	0.81	7
Guaranteed	1	9	11	1.85	——	——
Found	1.61	8.92	12.58	2*	0.73	7.06
Guaranteed	1	9	11	1.85	——	——
Found	1.40	9.55	12.97	1.91*	0.64	7.06
Guaranteed	——	12	——	2.75	——	——
Found		11.44	14.19	2.28*		8.78
Below guarantee		0.56		0.45		
Guaranteed	3.50	9	10	3.40	——	——
Found	3.40	8.53	10.98	4.34*	2.22	6.80
Below guarantee		0.47				
Guaranteed	2.50	8	9	6	——	——
Found	2.45	8.35	10.30	5.66*	1.52	5.99
Below guarantee				0.34		
Guaranteed	0.80	9	11	1.08	——	——
Found	0.87	11.20	14.88	1.21*	0.08	8.08
Guaranteed	——	13	15	——	——	——
Found		13.68	16.78			5.29
Guaranteed	1.75	9	10	3	——	——
Found	1.68	9.75	13.21	3.50*	0.94	7.33
Guaranteed	0.65	11	12	1	——	——
Found	1.01	11.64	14.41	1.31*	0.15	7.82

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
E. Frank Coe Co., New York City.	Prize brand grain and grass fertilizer.	Springville.	3318
E. Frank Coe Co., New York City.	Prize brand rye fertilizer.	Troy.	3429
E. Frank Coe Co., New York City.	Ralston's Knickerbocker.	Ellicottville.	3301
E. Frank Coe Co., New York City.	Red brand.	Jamaica.	3080
E. Frank Coe Co., New York City.	Special potato fertilizer.	Redwood.	3774
E. Frank Coe Co., New York City.	XXV phosphate.	Ellicottville. Homer.	3300 3641
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Ammoniated bone superphosphate.	Ellicottville. Oneonta. Parish.	3309 3566 3730
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Ammoniated wheat and corn phosphate.	Angola. Saratoga. Phœnix.	3273 3393 3691
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Chautauqua County special.	Dunkirk.	3268
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Crocker's phosphate.	Cooperstown.	3571
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Erie.	Ellicottville.	3307

lected in New York State During the Spring of 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	0.40	11	——	1	——	——
Found	0.72	11.34	14.36	1.08*	0.14	8.21
Guaranteed	0.43	9.30	11	1	——	——
Found	1.06	10.97	14.35	1.51*	0.23	7.11
Guaranteed	1.65	8	——	1.25	——	——
Found	2.06	10.60	14.09	1.89*	1.29	6.75
Guaranteed	3.50	9	10	6	——	——
Found	3.44	8.36	10.40	6.31*	2.10	6.36
Below guarantee		0.64				
Guaranteed	1.65	9	11	3.50	——	——
Found	1.86	10.31	12.67	3.01*	0.66	8.03
Below guarantee				0.49		
Guaranteed	1	8	9	1	——	——
Found	1.40	10.53	13.81	1.42*	0.19	7.41
Guaranteed	2.90	10	11	1.08	——	——
Found	3.20	10.56	10.97	1.35	1.13	8.95
Guaranteed	2	10	11	1.60	——	——
Found	2.26	10.16	11.89	1.94	0.79	7.25
Guaranteed	1.64	10	——	2	——	——
Found	1.78	10.94	13.80	2.26	0.78	7.90
Guaranteed	1.20	10	11	1.50	——	——
Found	1.02	10.60	11.84	1.62	0.54	5.67
Guaranteed	——	11	——	——	——	——
Found		11.56	13.56			3.39

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	General crop phosphate.	Norwich. Oswego.	3540 3611
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Market garden special.	Bayside.	3091
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	New rival ammoniated superphosphate.	Chester. Angola. Owego.	3190 3272 3608
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Niagara phosphate.	Owego.	3610
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Potato, hop and tobacco phosphate.	Ellicottville. Saratoga. Owego.	3308 3392 3612
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Practical ammoniated bone superphosphate.	Angola. Phœnix.	3271 3692
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Special manure.	Boonville.	3785
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Universal grain grower.	Westfield. Milford. Owego.	3258 3575 3609
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Vernon's onion special.	Florida.	3198
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Wheat, oats and corn fertilizer.	Homer.	3639
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	W. & H. high grade potato manure.	Riverhead.	3131

lected in New York State During the Spring of 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	0.82	7	8	1.08	———	———
Found	0.97	7.14	8.27	1.22	0.11	2.75
Guaranteed	3.70	8	9	8	———	———
Found	3.90	8.27	9.45	8.93	0.47	7.37
Guaranteed	1.23	10	11	1.60	———	———
Found	1.21	9.97	11.62	1.75	0.51	5.50
Guaranteed	———	11.50	12.50	———	———	———
Found		11.96	12.72			3.79
Guaranteed	2	10	11	3.25	———	———
Found	2.12	10.13	11.71	3.88	1.40	4.88
Guaranteed	0.82	8	9	1.08	———	———
Found	1.00	8.45	10.05	1.32	0.41	4.67
Guaranteed	4.50	8	9	5.40	———	———
Found	4.19	7.60	9.30	5.70		5.22
Below guarantee	0.31	0.40				
Guaranteed	0.82	7	8	2.70	———	———
Found	1.20	7.35	9.73	2.84	0.62	4.83
Guaranteed	2	9	10	3.10	———	———
Found	2.01	9.43	12.58	3.47	0.33	6.91
Guaranteed	1	8	9	1.60	———	———
Found	1.19	8.12	11.28	1.87	0.26	5.49
Guaranteed	3.28	10	11	8	———	———
Found	3.13	11.09	11.23	9.22	0.67	8.76

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Cuba Fertilizer Co., Cuba, N. Y.	Buckwheat special.	Cuba.	3290
Cuba Fertilizer Co., Cuba, N. Y.	Competition.	Fredonia.	3232
Cuba Fertilizer Co., Cuba, N. Y.	Dissolved bone and potash.	Cuba.	3288
Cuba Fertilizer Co., Cuba, N. Y.	Hustler.	Fredonia.	3231
Cuba Fertilizer Co., Cuba, N. Y.	Potato and corn manure.	Cuba.	3289
Cuba Fertilizer Co., Cuba, N. Y.	Standard.	Cuba.	3291
Cumberland Bone Phosphate Co., Portland, Me.	Ammoniated dissolved bone.	Demster.	3711
Cumberland Bone Phosphate Co., Portland, Me.	Bone and potash.	Westfield. Schenectady.	3261 3464
Cumberland Bone Phosphate Co., Portland, Me.	Concentrated phosphate.	Schenectady. Demster.	3463 3712
Cumberland Bone Phosphate Co., Portland, Me.	Dissolved bone phosphate.	Schenectady.	3465
Cumberland Bone Phosphate Co., Portland, Me.	Fruit and vine.	Schenectady. Demster.	3468 3710

lected in New York State During the Spring of 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	——	14	15	——	——	——
Found		14.17	15.30			10.11
Guaranteed	0.83	8	——	1	——	——
Found	0.97	8.69	10.31	1.17	0.56	6.12
Guaranteed	——	10	——	4	——	——
Found		11.23	11.80	4.22		7.41
Guaranteed	0.83	8	——	4	——	——
Found	0.96	8.51	10.24	4.22	0.53	6.52
Guaranteed	2.47	7	——	8	——	——
Found	2.38	7.46	9.39	8.08	1.09	4.61
Guaranteed	1.23	10	——	3	——	——
Found	1.39	9.75	10.95	3.14	0.82	7.07
Below guarantee		0.25				
Guaranteed	1.65	9	10	2	——	——
Found	2.39	9.66	11.03	2.36	0.64	5.91
Guaranteed	——	8	12	2.50	——	——
Found		10.01	14.29	3.02*		0.99
Guaranteed	3	8	10	7	——	——
Found	3.10	8.02	11.46	7.35	1.44	1.71
Guaranteed	——	10	13	——	——	——
Found		10.92	15.81			1.86
Guaranteed	0.82	4	10	8	——	——
Found	1.82	6.52	10.64	9.44*	0.48	1.72

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Cumberland Bone Phosphate Co., Portland, Me.	Guano.	Westfield. Schenectady. Mt. Pleasant.	3263 3467 3697
Cumberland Bone Phosphate Co., Portland, Me.	Hawkeye.	Westfield.	3262
Cumberland Bone Phosphate Co., Portland, Me.	Potato fertilizer.	Gloversville. Mt. Pleasant.	3506 3695
Cumberland Bone Phosphate Co., Portland, Me.	Seeding down fertilizer.	Schenectady. Mt. Pleasant.	3466 3696
Cumberland Bone Phosphate Co., Portland, Me.	Superphosphate.	Schenectady. Demster.	3462 3525
L. B. Darling Fertilizer Co., Pawtucket, R. I.	" A " brand	Greenport.	3108
L. B. Darling Fertilizer Co., Pawtucket, R. I.	" AA " brand.	Greenport.	3111
L. B. Darling Fertilizer Co., Pawtucket, R. I.	" B " brand.	Greenport.	3109
L. B. Darling Fertilizer Co., Pawtucket, R. I.	Blood, bone and potash.	Greenport.	3112
L. B. Darling Fertilizer Co., Pawtucket, R. I.	" C " brand.	Greenport.	3110
L. B. Darling Fertilizer Co., Pawtucket, R. I.	Pure dissolved bone.	Greenport.	3113

lected in New York State During the Spring of 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds o fertilizer.
Guaranteed	1.03	8	10	2	——	——
Found	1.19	9.69	11.01	2.40	0.34	4.14
Guaranteed	0.82	7	9	1	——	——
Found	1.16	8.07	10.24	1.37	0.39	4.34
Guaranteed	2.06	9	11	3	——	——
Found	2.07	9.68	12.47	3.30	0.60	6.74
Guaranteed	0.82	7	9	1	——	——
Found	1.07	8.35	10.01	1.37	0.37	5.91
Guaranteed	2.06	8	10	2	——	——
Found	2.48	9.72	12.82	2.54	0.60	3.72
Guaranteed	2.88	5	10	7	——	——
Found	3.30	5.39	12.48	7.40	0.83	1.65
Guaranteed	2.88	8	10	7	——	——
Found	2.98	7.03	11.44	8.28	0.74	3.47
Below guarantee		0.97				
Guaranteed	3.50	7	——	5	——	——
Found	3.21	8.31	12.55	6.10	0.90	4.13
Below guarantee	0.29					
Guaranteed	4.50	7	9	7	——	——
Found	4.03	7.31	8.32	8.53	1.89	3.50
Below guarantee	0.47					
Guaranteed	4	6	——	10	——	——
Found	3.50	6.52	11.35	11.24	1.50	3.05
Below guarantee	0.50					
Guaranteed	2	14	16	——	——	——
Found	2.22	14.52	15.67		1.44	8.44

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken	Station number.
Detrick Fertilizer and Chemical Co., Baltimore, Md.	Dilman Bros. special.	Geneva.	3345
Detrick Fertilizer and Chemical Co., Baltimore, Md.	Grain and grass mixture.	Havilah.	3266
Detrick Fertilizer and Chemical Co., Baltimore, Md.	Sheridan ammoniated bone.	Havilah.	3267
Louis F. Detrick, Baltimore, Md.	Bone and potash mixture.	Brocton.	3250
Louis F. Detrick, Baltimore, Md.	Kangaroo komplete kompound.	Brocton.	3246
Louis F. Detrick, Baltimore, Md.	Quick step bone phosphate.	Brocton.	3247
Louis F. Detrick, Baltimore, Md.	Sockless and shoeless aa phosphate.	Brocton.	3248
Louis F. Detrick, Baltimore, Md.	XXTRA acid phosphate.	Brocton.	3249
J. W. Dunbar, Attica, N. Y.	Grass and grain grower.	Attica.	3351
J. W. Dunbar, Attica, N. Y.	Oat and bean.	Attica.	3350
Eastern Farmers' Supply Association, Montclair, N. J.	Long Island special.	Jamaica.	3078

LECTED IN NEW YORK STATE DURING THE SPRING OF 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	2.47	7	—	15	—	—
Found	2.21	9.43	10.37	14.57	1.65	6.77
Below guarantee	0.26			0.46		
Guaranteed	—	10	11	2	—	—
Found		9.11	10.91	2.56		3.87
Below guarantee		0.89				
Guaranteed	1.65	10	12	2	—	—
Found	1.85	9.88	13.09	2.45	1.52	4.39
Guaranteed.	—	10	—	2.25	—	—
Found		10.46	13.94	2.43		7.01
Guaranteed	1.65	8	—	3	—	—
Found	1.66	9.13	12.88	2.82	0.77	5.76
Guaranteed	2.27	8	—	3	—	—
Found	2.21	9.68	12.69	2.60*	1.03	7.18
Below guarantee				0.40		
Guaranteed	1.03	8	—	1.25	—	—
Found	1.06	8.13	11.82	1.89	0.58	4.59
Guaranteed	—	14	14.75	—	—	—
Found		13.95	15.24			10.83
Guaranteed	1.23	8	—	3	—	—
Found	0.96	9.07	11.25	2.50*	0.40	5.76
Below guarantee	0.27			0.50		
Guaranteed	1.64	8	—	5	—	—
Found	1.47	8.22	10.70	4.65*	1.36	5.35
Below guarantee				0.35		
Guaranteed	3.25	8.50	9.50	8	—	—
Found	3.35	9.10	9.85	9.22	0.79	6.63

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Eureka Fertilizer Co., Avon, N. Y.	Eureka fertilizer.	Avon.	3385
Falcon Oil Works, Promised Land, N. Y.	Coarse fish scrap.	Jamaica.	3082
Farmers' and Builders' Supply Co., Owego, N. Y.	Ammoniated bone phosphate.	Owego.	3598
Farmers' and Builders' Supply Co., Owego, N. Y.	Buckwheat fertilizer.	Owego.	3599
Farmers' and Builders' Supply Co., Owego, N. Y.	Potato and tobacco fertilizer.	Owego.	3600
Farmers' and Builders' Supply Co., Owego, N. Y.	XXV.	Owego.	3597
Farmers' Fertilizer Co., Syracuse, N. Y.	Fair and square.	Franklinville.	3294
Farmers' Fertilizer Co., Syracuse, N. Y.	Farmers' soluble bone.	Dunkirk. Tully.	3241 3657
Farmers' Fertilizer Co., Syracuse, N. Y.	Mortgage lifter.	Perry. Fulton.	3361 3687
Farmers' Fertilizer Co., Syracuse, N. Y.	Phœnix ammoniated bone.	Dunkirk. Norwich. Tully.	3242 3537 3656
Farmers' Fertilizer Co., Syracuse, N. Y.	Reaper brand.	Fulton. Norwich. Tully.	3295 3538 3655

lected in New York State During the Spring of 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	—	10	—	3.75	—	—
Found		11.47	12.49	4.39		8.25
Guaranteed	7	—	5	—	—	—
Found	8.45		7.22		0.93	0.36
Guaranteed	0.82	9	—	2	—	—
Found	1.14	8.61	9.99	2.25	0.41	6.69
Below guarantee		0.39				
Guaranteed	—	14	15	—	—	—
Found		12.70	17.48			3.99
Below guarantee		1.30				
Guaranteed	2.47	7	8	8	—	—
Found	2.94	7.02	9.35	9.89	1.04	3.49
Guaranteed	0.82	8	10	4	—	—
Found	1.16	8.29	9.32	4.03	0.45	6.09
Guaranteed	2.47	7	8	0.54	—	—
Found	1.86	7.55	8.63	1.17	0.98	4.30
Below guarantee	0.61					
Guaranteed	—	6	7	2.25	—	—
Found		6.46	7.36	2.34		0.94
Guaranteed	—	5	—	3.25	—	—
Found		6.15	15.39	3.14		3.35
Guaranteed	1.40	5	6	1.63	—	—
Found	1.32	5.61	7.78	1.64	0.55	2.20
Guaranteed	1.65	5.50	7.50	4.32	—	—
Found	1.74	5.06	8.30	3.97	0.35	2.31
Below guarantee		0.44		0.35		

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Farmers' Fertilizer Co., Syracuse, N. Y.	Special potato and onion manure.	Tully. Fulton.	3658 3688
Farmers' Fertilizer Co., Syracuse, N. Y.	Special ammoniated bone.	Potsdam.	3777
Farmers' Fertilizer Co., Syracuse, N. Y.	Standard bone phosphate, special formula.	Dunkirk. Williamstown.	3240 3758
Farmers' Fertilizer Co., Syracuse, N. Y.	St. Lawrence Pomona grange.	Plum Brook.	3779
John Finster, Rome, N. Y.	Home trade bone eagle phosphate.	Rome.	3219 3748
H. Fitchard, Minetto, N. Y.	Minetto fertilizer.	Minetto. Caughdenoy.	3589 3737
Florida Manufacturing Co., Syracuse, N. Y.	Mortgage lifter.	Potsdam.	3778
Geo. B. Forrester, New York City.	Complete manure for potatoes.	Jamaica.	3063
Great Eastern Fertilizer Co., Rutland, Vt.	English wheat grower.	Voorheesville.	3457
Great Eastern Fertilizer Co., Rutland, Vt.	Garden special.	Jamaica. Bridgehampton. Mohawk.	3089 3147 3515
Great Eastern Fertilizer Co., Rutland, Vt.	General dissolved bone.	Voorheesville.	3458

LECTED IN NEW YORK STATE DURING THE SPRING OF 1897.

	Pounds of nitrogen in 100 pounds of fertil-izer.	Pounds of available phosphoric acid in 100 pounds of fertil-izer.	Pounds of total phosphoric acid in 100 pounds of fertil-izer.	Pounds of water-solu-ble potash in 100 pounds of fertil-izer.	Pounds of water-solu-ble nitrogen in 100 pounds of fertilizer.	Pounds of water-solu ble phos-phoric acid in 100 pounds of fertilizer.
Guaranteed	2.10	6.50	——	7	——	——
Found	2.28	7	7.83	6.60	0.15	3.62
Below guarantee				0.40		
Guaranteed	1.25	6	7	3.24	——	——
Found	1.28	5.56	9.28	3.53	0.30	0.59
Below guarantee		0.44				
Guaranteed	0.82	8	10	2.16	——	——
Found	1.10	7.82	9.50	2.06	0.30	4.39
Guaranteed	1.65	10	——	10	——	——
Found	1.51	11.44	13.34	10.98	1.04	7.53
Guaranteed	0.82	8	9	2	——	——
Found	0.91	7.17	9.70	1.73	0.44	1.62
Below guarantee		0.83		0.27		
Guaranteed	2.75	5	——	1.50	——	——
Found	2.52	7.19	9.04	1.04	1	3.14
Below guarantee	0.23			0.46		
Guaranteed	——	5	——	3.25	——	——
Found		7.39	19.11	2.13		3.29
Below guarantee				1.12		
Guaranteed	3.70	5.50	——	10	——	——
Found	4.20	7.08	7.18	10.95*	3.96	6.05
Guaranteed	0.82	8	9	2	——	——
Found	0.98	8.78	10.68	1.90	0.72	3.62
Guaranteed	3.29	6	——	8	——	——
Found	3.38	6.99	9.07	8.18	1.07	4.91
Guaranteed	——	14	——	——	——	——
Found		15.65	17.01			8.44

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Great Eastern Fertilizer Co., Rutland, Vt.	Grain and grass.	Camden.	3754
Great Eastern Fertilizer Co., Rutland, Vt.	Northern corn special.	Gloversville. Caughdenoy.	3508 3734
Great Eastern Fertilizer Co., Rutland, Vt.	Oats, buckwheat and seeding down fertilizer.	Gloversville. Adams.	3507 3766
Great Eastern Fertilizer Co., Rutland, Vt.	Soluble bone and potash.	Adams.	3767
Great Eastern Fertilizer Co., Rutland, Vt.	Vegetable, vine and tobacco.	Chester. Lishaskill. Caughdenoy.	3191 3479 3735
Geo. L. Harding, Binghamton, N. Y.	Harding's up-to-date.	Binghamton.	3596
S. M. Hess & Bro., Philadelphia, Pa.	Ammoniated bone superphosphate.	Sheridan.	3251
S. M. Hess & Bro., Philadelphia, Pa.	Keystone bone phosphate.	Mattituck. Sheridan.	3134 3252
S. M. Hess & Bro., Philadelphia, Pa.	Potato and truck manure.	Mattituck.	3135
Isaac C. Hendrickson, Jamaica, N. Y.	High grade fertilizer.	Jamaica.	3060
Isaac C. Hendrickson, Jamaica, N. Y.	Long Island fertilizer for peas.	Jamaica.	3059

LECTED IN NEW YORK STATE DURING THE SPRING OF 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	2.47	8	9	2	——	——
Found	2.36	8.10	8.98	1.97	1.06	5.67
Guaranteed	2.47	8	9	2	——	——
Found	2.92	9.82	11.64	1.94	1.55	0.33
Guaranteed	0.82	8	7	4	——	——
Found	0.87	11.93	12.44	3.94	0.39	1.79
Guaranteed	——	11	12	2	——	——
Found		7.39	8.55	1.33		1.50
Below guarantee		3.61		0.67		
Guaranteed	2.05	8	9	3.25	——	——
Found	2.09	8.60	10.14	3.90	0.96	3.97
Guaranteed	3.15	6.25	10	4.50	——	——
Found	3.96	7.69	10.87	5.15*	0.55	2.59
Guaranteed	1.60	8	——	2	——	——
Found	1.82	10.29	11.66	2.17	0.59	0.53
Guaranteed	0.80	9	——	1	——	——
Found	0.96	11.34	13.71	0.98	0.52	
Guaranteed	2.50	8	——	6	——	——
Found	2.64	9.08	11.34	6.22	0.88	3.23
Guaranteed	3.29	8	——	8	——	——
Found	1.96	8.08	9.24	8.57*	1.40	3.03
Below guarantee	1.33					
Guaranteed	1.65	6	——	6	——	——
Found	1.56	7.09	10.48	4.83*	0.93	
Below guarantee				1.17		

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Isaac C. Hendrickson, Jamaica, N. Y.	Long Island fertilizer.	Jamaica.	3061
Hughes & Wilkinson, Rome, N. Y.	Retriever ammoniated bone.	Rome.	3747
Imperial Fertilizer Co., New York City.	Imperial ten per cent guano.	Flatlands.	3105
Imperial Fertilizer Co., New York City.	Long Island special for potatoes and truck.	Flatlands.	3104
International Seed Co., Rochester, N. Y.	Grain and grass fertilizer.	Baldwinsville.	3676
International Seed Co., Rochester, N. Y.	Potato and truck manure.	Baldwinsville.	3677
Jarecki Chemical Co., Sandusky, Ohio.	C. O. D. phosphate.	North Java.	3381
Jarecki Chemical Co., Sandusky, Ohio.	Grain special.	South Lima.	3388
Jarecki Chemical Co., Sandusky, Ohio.	Lake Erie fish guano.	Perry.	3360
Jarecki Chemical Co., Sandusky, Ohio.	Wheat special.	North Java.	3382
Jones Fertilizing Co., Cincinnati, Ohio.	Miami Valley phosphate.	Otto.	3286

LECTED IN NEW YORK STATE DURING THE SPRING OF 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	2.47	6	—	6	—	—
Found	1.88	6.13	8.48	5.72	0.45	
Below guarantee	0.59			0.28		
Guaranteed	1.85	9	—	4	—	—
Found	1.88	9.31	13.13	4.44	0.69	6.42
Guaranteed	8.78	6	8	3	—	—
Found	8.08	7.32	9	3.52	6.25	4.59
Below guarantee	0.70					
Guaranteed	3.71	7	—	7	—	—
Found	3.51	7.31	8.12	7.62	1.85	6.95
Guaranteed	1.65	10	11	2	—	—
Found	1.83	9.70	12.66	2.64	0.63	3.38
Below guarantee		0.30				
Guaranteed	1.25	8	9	7	—	—
Found	1.66	9.47	11.91	6.68	0.74	4.13
Below guarantee				0.32		
Guaranteed	—	14	15	—	—	—
Found		15.03	17.42			10.25
Guaranteed	1.20	9	10	4	—	—
Found	1.78	10.73	12.67	3.51*	0.87	7.79
Below guarantee				0.49		
Guaranteed	1.65	10	11.50	1	—	—
Found	1.45	10.52	12.34	2.37*	0.55	4.92
Guaranteed	—	16	17	—	—	—
Found		14.78	17.37			9.32
Below guarantee		1.22				
Guaranteed	2.88	9	—	2.50	—	—
Found	2.64	7	11.63	3.11	0.39	1.92
Below guarantee	0.24	2				

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Jones Fertilizing Co., Cincinnati, Ohio.	Special tobacco grower.	Otto.	3285
F. R. Lalor, Dunnville, Ont., Can.	Maple brand Canadian hard wood ashes.	Parrish.	3733
Lazaretto Guano Co. Baltimore, Md.	Ammoniated bone phosphate special.	Norwich.	3545
Lazaretto Guano Co. Baltimore, Md.	Bone and potash mixture.	Sherburne.	3534
Lazaretto Guano Co. Baltimore, Md.	Corn special fertilizer.	Unadilla.	3552
Lazaretto Guano Co. Baltimore, Md.	Corn and oats special.	Sherburne.	3533
Lazaretto Guano Co. Baltimore, Md.	Corn, oats and grass special.	Norwich.	3541
Lazaretto Guano Co. Baltimore, Md.	Dissolved bone phosphate.	Watertown.	3769
Lazaretto Guano Co. Baltimore. Md.	Eaton's ammoniated bone phosphate.	Norwich.	3544
Lazaretto Guano Co. Baltimore, Md.	Eaton's special potato manure.	Norwich.	3543
Lazaretto Guano Co. Baltimore, Md.	Extra ammoniated bone.	Amsterdam. Oswego. Lacona.	3490 3699 3763

lected in New York State During the Spring of 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	2.49	9	———	2	———	———
Found	2.94	19.68	24.13	2.52*	0.64	2.28
Guaranteed	———	———	1	4.50	———	———
Found		0.64	1.50	5.15		
Guaranteed	0.82	8	———	4	———	———
Found	0.92	8.96	10.35	3.98	0.61	6.44
Guaranteed	———	10	11	2	———	———
Found		11.34	12.41	1.92		7.39
Guaranteed	2.06	8	9	3	———	———
Found	1.91	9.07	9.94	3.23	1.05	5.96
Guaranteed	1.03	8	9	3	———	———
Found	1.25	10	11.32	2.76	0.77	5.07
Below guarantee				0.24		
Guaranteed	1.02	8	9	3	———	———
Found	1.19	9.70	10.98	3.12	0.72	6.62
Guaranteed	———	14	———	———	———	———
Found		14.62	15.94			10.85
Guaranteed	2.06	8	9	3	———	———
Found	1.85	9.26	10.16	3.36	0.93	6.53
Below guarantee	0.21					
Guaranteed	0.82	8	9	4	———	———
Found	0.89	9.04	10.50	4.15	0.50	6.61
Guaranteed	0.82	8	———	4	———	———
Found	0.87	8.87	10.50	4.08	0.51	6.19

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Lazaretto Guano Co. Baltimore, Md.	Fruit and vine fertilizer.	Amsterdam.	3489
Lazaretto Guano Co. Baltimore, Md.	Hop and potato special—A brand.	Norwich.	3542
Lazaretto Guano Co. Baltimore, Md.	N. Y. standard potato manure.	Watertown.	3768
Lazaretto Guano Co. Baltimore, Md.	Northern corn grower.	Lorraine.	3764
Lazaretto Guano Co. Baltimore, Md.	Oats and buckwheat standard.	Unadilla.	3553
Lazaretto Guano Co. Baltimore, Md.	Potato, grain and grass phosphate.	Sherburne.	3532
Lazaretto Guano Co. Baltimore, Md.	Retriever animal bone.	Binghamton. Watertown.	3595 3771
Liebig Manufacturing Co. Carteret, N. J.	Fruit and vine.	Marlborough.	3205
Liebig Manufacturing Co. Carteret, N. J.	Peach tree No. 1.	Marlborough.	3186
Liebig Manufacturing Co. Carteret, N. J.	Potato and corn.	Marlborough.	3185
Liebig Manufacturing Co. Carteret, N. J.	Soluble bone and potash No. 2.	Marlborough.	3203

LECTED IN NEW YORK STATE DURING THE SPRING OF 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizers.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	0.82	10	12	8	———	———
Found	0.81	10.51	11.31	7.82	0.57	7.75
Guaranteed	0.82	10	11	8	———	———
Found	0.93	10.72	11.53	7.67	0.70	7.40
Below guarantee				0.33		
Guaranteed	2.47	7	———	8	———	———
Found	2.34	7.35	9.44	8	1.01	4.68
Guaranteed	0.82	8	9	4	———	———
Found	0.90	8.56	10.16	3.82	0.47	6.17
Guaranteed	0.82	8	9	4	———	———
Found	0.81	8.92	10.44	4.11	0.50	6.55
Guaranteed	0.82	8	9	4	———	———
Found	0.95	9.01	10.28	3.93	0.64	6.01
Guaranteed	1.65	9	———	4	———	———
Found	2.04	10.61	13.75	4.19	0.80	6.62
Guaranteed	1.60	8	———	7	———	———
Found	2	9.01	10.05	7.45*	0.54	0.78
Guaranteed	1.60	6	———	10	———	———
Found	1.98	7.87	8.52	11.22*	0.44	0.94
Guaranteed	2.75	6	7	6	———	———
Found	2.67	7.56	9.12	6.52	0.79	5.07
Guaranteed	———	12	———	2	———	———
Found		12.94	15.14	1.99		3.49

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Liebig Manufacturing Co. Carteret, N. J.	Standard ammoniated bone superphosphate.	Marlborough.	3204
Lister's Agri'l Chemical Works, Newark, N. J.	Ammoniated dissolved bone phosphate.	Schuylerville. Cortland. Baldwinsville.	3422 3631 3685
Lister's Agri'l Chemical Works. Newark, N. J.	Animal bone and potash No. 1.	Glens Falls. Parrish.	3398 3729
Lister's Agri'l Chemical Works. Newark, N. J.	Animal bone and potash No. 2.	Homer.	3643
Lister's Agri'l Chemical Works. Newark, N. J.	Cauliflower and cabbage fertilizer.	Jamaica.	3064
Lister's Agri'l Chemical Works. Newark, N. J.	Celebrated corn manure.	Glens Falls.	3403
Lister's Agri'l Chemical Works, Newark, N. J.	Celebrated ground bone.	New Suffolk. Troy.	3127 3432
Lister's Agri'l Chemical Works, Newark, N. J.	Corn fertilizer No. 2.	Orient. Glens Falls. Lacona.	3120 3339 3762
Lister's Agri'l Chemical Works. Newark, N. J.	Crescent bone dust.	Southampton.	3159
Lister's Agri'l Chemical Works. Newark, N. J.	Harvest queen.	Amsterdam.	3487
Lister's Agri'l Chemical Works. Newark, N. J.	Lawn fertilizer.	Utica.	3521

lected in New York State During the Spring of 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	2.25	10	———	1.50	———	———
Found	2.31	10.70	11.84	1.51*	0.83	
Guaranteed	1.81	9	11	1.50	———	———
Found	1.89	10.04	12.64	1.65	0.90	8.51
Guaranteed	———	9	10	5	———	———
Found		9.64	10.26	4.99		7.72
Guaranteed	———	10	11.50	3	———	———
Found		10.56	11.96	3.10		6
Guaranteed	3.70	7.50	8.50	7	———	———
Found	3.73	8.24	9.14	7.37	2.19	6.33
Guaranteed	3.70	7.50	8.50	7	———	———
Found	3.95	7.75	9.42	7.17	2.32	6.53
Guaranteed	2.70	———	12	———	———	———
Found	3.10		14.05		2.49	2.01
Guaranteed	1.81	9.25	12	4	———	———
Found	1.81	9.65	11.83	4.63	0.59	6.60
Guaranteed	2.26	———	11	———	———	———
Found	2.61		15.11		0.52	1.28
Guaranteed	1.24	9.50	11.50	2	———	———
Found	1.46	10.36	12.95	2.08	0.79	7.39
Guaranteed	1.65	7	8	3.50	———	———
Found	1.92	7.99	8.24	3.70*	1.73	5.88

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Lister's Agri'l Chemical Works, Newark, N. J.	Perfect.	Baldwinsville.	3683
Lister's Agri'l Chemical Works, Newark, N. J.	Potato manure No. 1.	Jamaica. Orient. Glens Falls.	3065 3119 3402
Lister's Agri'l Chemical Works, Newark, N. J.	Potato manure No. 2.	Brant. Glens Falls. Parrish.	3331 3401 3727
Lister's Agri'l Chemical Works, Newark, N. J.	Pure raw bone meal.	Troy.	3430
Lister's Agri'l Chemical Works, Newark, N. J.	Special potato manure.	Bridgehampton. Fort Edward. Cortland.	3145 3415 3627
Lister's Agri'l Chemical Works, Newark, N. J.	Special ten per cent manure.	Southampton. Foster's Meadow.	3157 3086
Lister's Agri'l Chemical Works, Newark, N. J.	Special wheat fertilizer.	Rochester.	3789
Lister's Agri'l Chemical Works, Newark, N. J.	Standard pure bone phosphate.	Troy. Bridgehampton. Parrish.	3431 3146 3728
Lister's Agri'l Chemical Works, Newark, N. J.	Success.	New Suffolk. Fort Edward. Lacona.	3126 3414 3761
Lister's Agri'l Chemical Works, Newark, N. J.	U. S. superphosphate.	Southampton. Homer.	3158 3642
Lister's Agri'l Chemical Works, Newark, N. J.	Vegetable compound.	Glens Falls.	3400

LECTED IN NEW YORK STATE DURING THE SPRING OF 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	1.24	9.50	11.50	1.50	——	——
Found	1.44	10.41	11.89	2.26	0.75	6.81
Guaranteed	3.70	7.50	9.50	7	——	——
Found	3.79	8.52	9.43	7.12	2.20	7
Guaranteed	1.81	9.25	12	4	——	——
Found	1.97	11.96	13.45	4.29	0.70	7.77
Guaranteed	3.25	——	23	——	——	——
Found	3.22		23.27		0.90	
Guaranteed	1.65	8	9	3	——	——
Found	1.80	9.87	10.75	3.69	0.74	6.91
Guaranteed	1.85	8.50	——	10	——	——
Found	1.83	9.99	12.40	9.91*	0.65	6.79
Guaranteed	1.65	8	9	3	——	——
Found	1.82	10.34	12.99	4.16	0.64	9.47
Guaranteed	2.35	10	12	1.50	——	——
Found	2.51	12.23	14.18	2.05	1.03	8.26
Guaranteed	1.24	9.50	11.50	2	——	——
Found	1.50	10.90	12.68	2.53	0.71	7.23
Guaranteed	1.32	7	8	2	——	——
Found	1.67	9.39	12.73	2.43*	0.67	5.26
Guaranteed	3.70	7.75	8.75	7	——	——
Found	3.95	7.45	8.87	7.28	2.27	6.51
Below guarantee		0.30				

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Lonergan & Livingston, Albany, N. Y.	Meat and bone.	Albany.	3446
Lorillard Co., Jersey City, N. J.	Improved tobacco dust.	Jamaica.	3062
W. E. Lowe, Geneseo, N. Y.	Lowe's special.	Geneseo.	3387
Lowell Fertilizer Co., Lowell, Mass.	Animal brand for general use.	Argyle.	3417
Lowell Fertilizer Co., Lowell, Mass.	Bone fertilizer for corn and grain.	Argyle. Newark Valley. Pulaski.	3416 3614 3722
Lowell Fertilizer Co., Lowell, Mass.	Cereal.	Newark Valley.	3616
Lowell Fertilizer Co., Lowell, Mass.	Empire.	Fultonville. Newark Valley. Pulaski.	3496 3615 3721
Lowell Fertilizer Co., Lowell, Mass.	Complete manure for vegetables.	Fonda. Pulaski.	3493 3720
Lowell Fertilizer Co., Lowell, Mass.	Potato phosphate.	Calverton.	3141
Frederick Ludlam, New York City.	Cereal.	Troy.	3434
Frederick Ludlam, New York City.	Dragon's tooth.	Calverton.	3141

lected in New York State During the Spring of 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	4	8	18	—	—	—
Found	3.95	8.73	18.78		1.56	
Guaranteed	2.47	—	—	8	—	—
Found	2.69	0.26	0.72	8.89*	1.98	0.26
Guaranteed	—	10	12	6	—	—
Found		10.85	12.12	5.03*		7.59
Below guarantee				0.97		
Guaranteed	2.46	9	10	4	—	—
Found	2.97	9.07	10.53	3.99*	1.31	4.16
Guaranteed	1.65	8	9	3	—	—
Found	1.79	8.50	10.53	3.24*	0.68	4.38
Guaranteed	0.82	7	—	1	—	—
Found	1.08	7.20	9.23	0.93	0.44	2.93
Guaranteed	1.25	7	8	2	—	—
Found	1.51	7.90	9.81	1.98	0.62	3.65
Guaranteed	2	8	9	3.50	—	—
Found	2.07	11.15	13.64	3.61	0.93	6.62
Guaranteed	2.47	8	9	6	—	—
Found	2.80	9.68	11.07	5.55*	1.39	5.61
Below guarantee				0.45		
Guaranteed	0.82	8	10	1	—	—
Found	1.09	9.05	13.25	1.37	0.30	4.20
Guaranteed	3	7	—	7	—	—
Found	3.67	8.93	10.54	7.13	1.39	6.17

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Z. F. Magill, Troy, N. Y.	Crematory ashes.	Troy. Fonda.	3437 3495
Mapes Formula & Peruvian Guano Co., New York City.	Cabbage and cauliflower manure.	Littleneck.	3093
Mapes Formula & Peruvian Guano Co., New York City.	Cereal brand.	Newburg. Binghamton.	3179 3590
Mapes Formula & Peruvian Guano Co., New York City.	Complete manure, "A" brand.	Littleneck. Binghamton.	3095 3591
Mapes Formula & Peruvian Guano Co., New York City.	Complete manure for light soils.	Newburg.	3180
Mapes Formula & Peruvian Guano Co., New York City.	Corn manure.	Littleneck.	3094
Mapes Formula & Peruvian Guano Co., New York City.	Economical potato manure.	Orient. Newburg. Binghamton.	3118 3178 3592
Mapes Formula & Peruvian Guano Co., New York City.	Grass and grain spring top-dressing.	Newburg.	3181
Mapes Formula & Peruvian Guano Co., New York City.	Potato manure, L. I. special.	Littleneck.	3096
Mapes Formula & Peruvian Guano Co., New York City.	Pure ground bone.	Newburg.	3177
Maxson & Starin, Cortland, N. Y.	Cortland Co. special.	Cortland.	3620

LECTED IN NEW YORK STATE DURING THE SPRING OF 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	0.56	—	3.91	2.15	—	—
Found	0.82	0.66	2.26	1.16	0.45	
Below guarantee				0.99		
Guaranteed	4.10	6	8	6	—	—
Found	3.90	5.47	7.95	6.87	1.85	2.97
Below guarantee		0.53				
Guaranteed	1.65	6	8	3	—	—
Found	2.24	7.60	9.01	3.78	0.41	5.89
Guaranteed	2.47	10	12	2.50	—	—
Found	3.17	10.54	12.97	3.14	1.59	7.10
Guaranteed	4.95	6	8	6	—	—
Found	5.29	7.51	9.49	6.90	2.13	5.52
Guaranteed	2.47	8	10	6	—	—
Found	2.63	8.77	10.15	6.87	1.42	7.07
Guaranteed	3.29	4	6	8	—	—
Found	3.41	5.92	7.80	7.84*	1.63	2.99
Guaranteed	4.94	5	6	7	—	—
Found	5.24	6.12	7.43	7.77	3.33	4.22
Guaranteed	3.29	4	6	7	—	—
Found	3.68	5.68	8.94	7.35*	1.79	2.21
Guaranteed	2.88	—	24	—	—	—
Found	3.98		23.64		0.30	
Guaranteed	2	9	—	2	—	—
Found	1.94	9.43	11.70	2.36	0.49	6.06

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Maxson & Starin, Cortland, N. Y.	Fruit and vine.	Cortland.	3619
Maxson & Starin, Cortland, N. Y.	Potato and cabbage special.	Cortland.	3622
Maxson & Starin, Cortland, N. Y.	Vegetable and onion special.	Cortland.	3621
Maxson & Starin, Cortland, N. Y.	XXX guano.	Cortland.	3618
Wm. B. McDowell, Middletown, N. Y.	Bone dust.	Middletown.	3201
Wm. B. McDowell, Middletown, N. Y.	Fertilizer.	Middletown.	3200
Michigan Carbon Works, Detroit, Mich.	Desiccated bone.	Fredonia.	3235
Michigan Carbon Works, Detroit, Mich.	Homestead.	Lacona.	3239
Michigan Carbon Works, Detroit, Mich.	Homestead potato grower.	Evans.	3275
Michigan Carbon Works, Detroit, Mich.	Jarves drill phosphate.	Evans.	3274
Michigan Carbon Works, Detroit, Mich.	Perfection fruit grower.	Fredonia.	3234

lected in New York State During the Spring of 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	1.65	7	—	9	—	—
Found	1.61	7.73	10.03	8.59	0.58	5.10
Below guarantee				0.41		
Guaranteed	3.70	8	—	6	—	—
Found	3.38	8.87	10.79	5.90	1.82	6.07
Below guarantee	0.32					
Guaranteed	4.95	8	—	6	—	—
Found	4.23	9.92	10.03	6.92	2.59	6.58
Below guarantee	0.72					
Guaranteed	0.82	8	—	4	—	—
Found	0.91	8.62	10.25	4.02	0.51	6.06
Guaranteed	3.05	7	16	3.68	—	—
Found	3.57	7.16	14.07	3.47	1.08	
Below guarantee				0.21		
Guaranteed	5.35	5.58	11.48	8.60	—	—
Found	5.28	5.71	10.73	9.36*	3.41	
Guaranteed	1.25	—	25	—	—	—
Found	1.34		28.76		0.45	
Guaranteed	1.85	8	8.50	1.50	—	—
Found	2.41	10.02	11.10	1.62	0.70	6.44
Guaranteed	1.94	8.50	10	5	—	—
Found	2.30	8.95	10.39	5.31	1.15	7.36
Guaranteed	1	8	10	0.75	—	—
Found	1.24	9.10	9.67	1.36	0.43	6.17
Guaranteed	0.80	10	11	7	—	—
Found	1.09	11.31	13.23	7.82	0.20	2.04

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Milsom Rendering and Fertilizer Co., Buffalo, N. Y.	Attica special.	Attica.	3348
Milsom Rendering and Fertilizer Co., Buffalo, N. Y.	Ballsmith & Moritz's special.	Attica.	3349
Milsom Rendering and Fertilizer Co., Buffalo, N. Y.	Buckwheat special.	Springville.	3316
Milsom Rendering and Fertilizer Co., Buffalo, N. Y.	Buffalo fertilizer.	Kingston. Gloversville. Tully.	3207 3510 3653
Milsom Rendering and Fertilizer Co., Buffalo, N. Y.	Buffalo guano.	West Winfield. Fulton.	3523 3689
Milsom Rendering and Fertilizer Co., Buffalo, N. Y.	Cyclone pure bone meal.	Fredonia. Johnstown.	3229 3497
Milsom Rendering and Fertilizer Co., Buffalo, N. Y.	Dissolved bone.	Gloversville.	3511
Milsom Rendering and Fertilizer Co., Buffalo, N. Y.	Dissolved bone and potash.	Otto. Gloversville. Boonville.	3284 3512 3786
Milsom Rendering and Fertilizer Co., Buffalo, N. Y.	Erie king.	Kingston. Fort Edward. Tully.	3206 3411 3654
Milsom Rendering and Fertilizer Co., Buffalo, N. Y.	Potato, hop and tobacco phosphate.	Calverton. Fort Edward. Pulaski.	3140 3413 3723
Milsom Rendering and Fertilizer Co., Buffalo, N. Y.	Rathbun's special.	Wellsville.	3383

LECTED IN NEW YORK STATE DURING THE SPRING OF 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	0.85	8	8.50	4	—	—
Found	1.04	7.31	9.82	4.21	0.64	5.54
Below guarantee		0.69				
Guaranteed	1.85	8	9	4	—	—
Found	1.77	8.47	10.13	3.53	0.54	6.26
Below guarantee				0.47		
Guaranteed	0.80	7	—	1	—	—
Found	0.92	6.64	9.02	0.88	0.49	4.53
Below guarantee		0.36				
Guaranteed	1.85	8	9	1.50	—	—
Found	1.76	7.80	9.74	1.35	0.74	5.40
Guaranteed	0.80	8	9	4	—	—
Found	0.91	7.72	9.87	3.04	0.41	5.09
Below guarantee		0.28		0.96		
Guaranteed	2.40	—	22	—	—	—
Found	3.58		23.34		1.55	
Guaranteed	—	11	12.37	—	—	—
Found		11.65	12.39			5.94
Guaranteed	—	9	11	1.65	—	—
Found		10.22	10.75	1.76		4.93
Guaranteed	0.80	7	9	2	—	—
Found	0.96	6.93	8.99	1.62	0.50	4.84
Below guarantee				0.38		
Guaranteed	2	8	9	4	—	—
Found	1.87	8.04	9.68	4.56	0.66	6.21
Guaranteed	0.82	7	9	1	—	—
Found	0.98	6.73	9.49	0.89	0.59	4.41
Below guarantee		0.27				

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Milsom Rendering and Fertilizer Co., Buffalo, N. Y.	Scoville's special.	Varysburg.	3371
Milsom Rendering and Fertilizer Co., Buffalo, N. Y.	Special bean fertilizer.	Perry. Philadelphia.	3365 3772
Milsom Rendering and Fertilizer Co., Buffalo, N. Y.	Special potato fertilizer.	Calverton. Langford. Gloversville.	3138 3339 3509
Milsom Rendering and Fertilizer Co., Buffalo, N. Y.	Vegetable bone.	Springville. Clinton.	3315 3746
Milsom Rendering and Fertilizer Co., Buffalo, N. Y.	Wheat, oats and barley phosphate.	Fredonia. Fort Edward. Fulton.	3228 3412 3690
Mittenmaier & Sons, Rome, N. Y.	Hop and potato fertilizer.	Rome.	3218 3749
Mittenmaier & Sons, Rome, N. Y.	Pride of America.	Rome. Clinton.	3217 3745
Mittenmaier & Sons, Rome, N. Y.	Superphosphate.	Rome.	3751
Moller & Co., Maspeth, N. Y.	Champion No. 1.	Jamaica.	3090
National Fertilizer Co., Bridgeport, Conn.	Ammoniated bone phosphate.	Fonda.	3491
National Fertilizer Co., Bridgeport, Conn.	Chittenden's fish and potash.	Gloversville.	3501

lected in New York State During the Spring of 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	1.85	8	—	4	—	—
Found	2.17	8.30	9.79	4.10	0.87	6.16
Guaranteed	0.82	10	11	4	—	—
Found	1.21	9.98	12.13	4.32	0.71	7.25
Guaranteed	1.64	8	10	8	—	—
Found	1.72	7.91	8.78	8.04	0.22	6.17
Guaranteed	4.12	8	—	5	—	—
Found	4.04	9.15	9.83	5.33	0.34	6.57
Guaranteed	1.23	8	9	2	—	—
Found	1.19	7.92	9.81	1.02	0.70	4.83
Below guarantee				0.38		
Guaranteed	1	6	—	3	—	—
Found	0.91	6.01	9.87	3.47*	0.40	3.07
Guaranteed	1	6	—	2	—	—
Found	1.03	6.31	9.45	2.39*	0.39	2.79
Guaranteed	2	8	—	4	—	—
Found	1.20	6.45	10.24	3.91	0.43	2.75
Below guarantee	0.80	1.55				
Guaranteed	3.30	6	—	6	—	—
Found	3.24	7.03	9.76	7.26*	2.07	2.43
Guaranteed	1.65	8	10	2	—	—
Found	1.99	7.99	12.69	2.68*	0.25	3.45
Guaranteed	2.50	—	8	3	—	—
Found	2.39	5.72	8.17	4.08	0.24	1.84

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
National Fertilizer Co., Bridgeport, Conn.	Chittenden's kainit.	Foster's Meadow.	3088
National Fertilizer Co., Bridgeport, Conn.	Chittenden's potato phosphate.	Springfield. Gloversville. Mattituck.	3085 3502 3136
National Fertilizer Co., Bridgeport, Conn.	Chittenden's root fertilizer.	Springfield.	3070
National Fertilizer Co., Bridgeport, Conn.	Universal.	Utica.	3522
National Fertilizer Co., Bridgeport, Conn.	Fish and potash.	Mattituck.	3137
National Fertilizer Co., Bridgeport, Conn.	Market garden fertilizer.	Springfield.	3084
Newburgh Rendering Co., Newburgh, N. J.	Pure meat and bone.	Newburgh.	3202
New York Fertilizer & Chemical Co., Roselle, N. J.	Cabbage, potato and vegetable manure.	Flatlands.	3102
New York Fertilizer & Chemical Co., Roselle, N. J.	Standard potato and vegetable manure.	Flatlands.	3103
Niagara Fertilizer Co., Buffalo, N. Y.	Grain and grass grower.	Springville. Sherburne. Williamstown.	3313 3529 3760
Niagara Fertilizer Co., Buffalo, N. Y.	Ground bone meal.	Springville.	3312

lected in New York State During the Spring of 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds o fertilizer.
Guaranteed	——	——	——	12	——	——
Found				12.15		
Guaranteed	2	6	8	8	——	——
Found	3.46	9.53	10.26	8.93*	2.33	5.99
Guaranteed	3.30	8	10	6	——	——
Found	3.26	8.08	10.02	7.06	1.36	6.11
Guaranteed	0.82	9	——	1	——	——
Found	1.14	12.75	13.82	0.80	0.57	0.62
Below guarantee						
Guaranteed	3	——	6	4	——	——
Found	2.37		8.44	3.80	0.31	
Below guarantee	0.63					
Guaranteed	2.50	7	9	6	——	——
Found	3.51	8.47	10.87	6.24	1.78	5.79
Guaranteed	4	——	20	——	——	——
Found	5.68		15.79		1.27	
Below guarantee			4.21			
Guaranteed	4.10	6	——	8	——	——
Found	5.45	4.69	5.78	11.36	0.90	2.33
Below guarantee		1.31				
Guaranteed	3.28	5	——	10	——	——
Found	4.18	4.73	6.30	12.58	0.61	3.24
Below guarantee		0.27				
Guaranteed	0.82	7	8	1.08	——	——
Found	1.04	7.68	8.35	1.25	0.11	4.44
Guaranteed	2	——	25	——	——	——
Found	1.82		30.54		0.10	

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Niagara Fertilizer Co., Buffalo, N. Y.	Queen City phosphate.	Springville.	3314
Niagara Fertilizer Co., Buffalo, N. Y.	Potato, hop and tobacco phosphate.	Springville. Cobleskill.	3311 3577
Niagara Fertilizer Co., Buffalo, N. Y.	Triumph.	Ellicottville.	3305
Niagara Fertilizer Co., Buffalo, N. Y.	Wheat and corn producer.	Ellicottville. Cobleskill. Williamstown.	3306 3578 3579
Northwestern Fertilizer Co., Chicago, Ill.	Acidulated bone and potash.	Jamestown.	3226
Northwestern Fertilizer Co., Chicago, Ill.	Challenge corn grower.	Jamestown.	3227
Oakfield Fertilizer Co., Buffalo, N. Y.	Golden sheaf.	Jamestown.	3223
Oakfield Fertilizer Co., Buffalo, N. Y.	Great value.	Fredonia.	3236
Oakfield Fertilizer Co., Buffalo, N. Y.	High farming.	Fredonia.	3237
Oakfield Fertilizer Co., Buffalo, N. Y.	Potato and tobacco.	Jamestown.	3225
Oakfield Fertilizer Co., Buffalo, N. Y.	Pure ground bone.	Fredonia.	3238

lected in New York State During the Spring of 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	———	11	———	———	———	———
Found		11.74	12.24			4.97
Guaranteed	1.64	8	9	2.70	———	———
Found	1.74	10.34	11.97	3	0.21	7.57
Guaranteed	2.47	8	9	2.16	———	———
Found	2.61	7.86	11.04	2.54	0.84	5.43
Guaranteed	1.23	8	9	2.16	———	———
Found	1.48	8.07	11.33	2.54	0.78	5.45
Guaranteed	0.82	10	———	1.50	———	———
Found	0.99	10.97	14.65	1.52*	0.75	8.12
Guaranteed	2.06	8	12	0.54	———	———
Found	2.63	7.60	12.08	0.93	1.07	4.71
Below guarantee		0.40				
Guaranteed	1.23	7	———	1.89	———	———
Found	1.32	7.09	7.93	2.10	0.04	4.51
Guaranteed	0.82	6	7	1.08	———	———
Found	1.08	6.74	7.49	1.27	0.02	3.29
Guaranteed	1.85	8	9	2.43	———	———
Found	1.87	7.94	8.92	2.24	0.17	5.10
Guaranteed	2.47	6	———	4.32	———	———
Found	2.77	5.11	6.91	4.36*	0.12	2.94
Below guarantee		0.89				
Guaranteed	2.88	———	25	———	———	———
Found	3.37		23.73		1.03	
Below guarantee			1.27			

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Oakfield Fertilizer Co., Buffalo, N. Y.	Standard.	Jamestown.	3224
Oneonta Fertilizer & Chemical Co., Oneonta, N. Y.	Complete buckwheat fertilizer.	Oneonta.	3565
Oneonta Fertilizer & Chemical Co., Oneonta, N. Y.	Complete corn manure.	Oneonta.	3562
Oneonta Fertilizer & Chemical Co., Oneonta, N. Y.	Complete manure for general use.	Oneonta.	3560
Oneonta Fertilizer & Chemical Co., Oneonta, N. Y.	Complete manure for vegetables.	Oneonta.	3559
Oneonta Fertilizer & Chemical Co., Oneonta, N. Y.	Complete potato manure.	Oneonta.	3561
Oneonta Fertilizer & Chemical Co., Oneonta, N. Y.	Corn fertilizer.	Unadilla.	3555
Oneonta Fertilizer & Chemical Co., Oneonta, N. Y.	Economical manure.	Unadilla.	3554
Oneonta Fertilizer & Chemical Co., Oneonta, N. Y.	Hop phosphate.	Oneonta.	3563
Oneonta Fertilizer & Chemical Co., Oneonta, N. Y.	Kainit.	Oneonta.	3564
Oneonta Fertilizer & Chemical Co., Oneonta, N. Y.	Potato fertilizer.	Oneonta.	3557

lected in New York State During the Spring of 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	2.47	10	——	1.62	——	——
Found	2.63	10.10	11.60	1.89	0.16	6.81
Guaranteed	1.65	5	6	1	——	——
Found	1.50	5.13	6.21	1.44	0.85	1.49
Guaranteed	3.70	7	9	6	——	——
Found	3.70	7.35	8.04	6.39	1.41	3.83
Guaranteed	3.30	8	10	4	——	——
Found	3.08	8.71	9.06	4.20	0.45	5.31
Below guarantee	0.22					
Guaranteed	5	6	8	6	——	——
Found	4.60	6.89	7.74	6.22	0.82	4.72
Below guarantee	0.40					
Guaranteed	3.70	7.50	8	7	——	——
Found	4.02	8.19	9.65	6.99*	2.20	4.11
Guaranteed	2.50	6	7	3	——	——
Found	2.45	6.83	7.68	4.96	0.28	2.71
Guaranteed	1.65	5	6	5	——	——
Found	1.69	6.03	7.31	4.88	0.45	2.05
Guaranteed	1.65	9	9	4	——	——
Found	1.75	9.06	10.31	4.10*	0.78	4.34
Guaranteed	——	——	——	12	——	——
Found				14.58		
Guaranteed	1.85	6	7	5	——	——
Found	1.73	6.03	7.31	4.88*	0.88	1.91

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Oneonta Fertilizer & Chemical Co., Oneonta, N. Y.	Standard superphosphate.	Oneonta.	3556
Oneonta Fertilizer & Chemical Co., Oneonta, N. Y.	Superphosphate success.	Oneonta.	3558
Pacific Guano Co., Boston, Mass.	A No. 1 phosphate.	Oneida. Sherburne. Cooperstown.	3215 3536 3572
Pacific Guano Co., Boston, Mass.	C. A. D. special.	South Lima.	3389
Pacific Guano Co., Boston, Mass.	Dissolved bone phosphate.	Oneida. Amsterdam.	3214 3486
Pacific Guano Co., Boston, Mass.	Dissolved bone and potash.	Springville. Cooperstown.	3319 3573
Pacific Guano Co., Boston, Mass.	Nobsque guano.	Oneida. Schuylerville. Baldwinsville.	3213 3421 3678
Pacific Guano Co., Boston, Mass.	Potato, tobacco and hop fertilizer.	Oneida. Sherburne.	3216 3535
Pacific Guano Co., Boston, Mass.	Soluble Pacific guano.	Springville. Amsterdam. Baldwinsville.	3320 3485 3682
Packers' Union Fertilizer Co., New York City.	Gardener's complete manure.	Southold.	3125
Packers' Union Fertilizer Co., New York City.	Potato manure.	Orient.	3117

lected in New York State During the Spring of 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	1.65	7	8	3	———	———
Found	1.88	7.50	8.58	3.30	0.91	2.75
Guaranteed	1	8	10	2.50	———	———
Found	1.02	7.98	8.99	2.64	0.65	2.47
Guaranteed	1.03	7	8	1.50	———	———
Found	1.29	9.04	10.75	2.14	0.56	4.81
Guaranteed	0.82	7	———	15	———	———
Found	1.94	8.69	10.24	15.19	0.80	5.64
Guaranteed	———	13	14	———	———	———
Found		15.52	16.07			11.30
Guaranteed	———	10	11	2	———	———
Found		11.49	13.17	2.16		7.88
Guaranteed	1.15	8	9	2	———	———
Found	1.18	8.48	10.65	2.03	0.37	3.30
Guaranteed	2.06	8	9	3	———	———
Found	2.59	7.99	11.98	3.16	0.94	3.02
Guaranteed	2.05	8	10	1.50	———	———
Found	2.33	9.36	11.36	2.02	0.83	2.59
Guaranteed	2.47	8	10	10	———	———
Found	2.79	9.04	10.35	8.31	1.62	4.64
Below guarantee				1.69		
Guaranteed	2.06	8	9	6	———	———
Found	2.46	8.85	10.22	7.37	2.05	5.81

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Packers' Union Fertilizer Co., New York City	Universal.	Southold.	3124
Patapsco Guano Co., Baltimore, Md.	Grain and tobacco.	Baldwinsville.	3681
A. Peterson, Penfield, N. Y.	Farmers' benefit.	Penfield.	3791
A. Peterson, Penfield, N. Y.	Penfield standard.	Penfield.	3790
Moro Phillips Chemical Co., Springville, N. Y.	Springville fertilizer.	Springville.	3310
B. J. Pine, East Williston, N. Y.	Star raw bone superphosphate.	East Williston.	3097
Powers, Gibbs & Co., Wilmington, N. C.	Ammoniated guano.	Mohawk.	3517
Powers, Gibbs & Co., Wilmington, N. C.	Seabird ammoniated guano.	Mohawk.	3516
Powers, Gibbs & Co., Wilmington, N. C.	Special small grain guano.	Saratoga.	3391
Powers, Gibbs & Co., Wilmington, N. C.	Truck farmer's special guano.	Troy.	3433
Preston Fertilizer Co., Brooklyn, N. Y.	Ammoniated bone superphosphate.	Poughkeepsie.	3168

LECTED IN NEW YORK STATE DURING THE SPRING OF 1897.

	Pounds of nitrogen in 100 pounds of of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	0.82	8	9	5	—	—
Found	2.50	8.64	10.09	5.12	1.61	6.20
Guaranteed	1.65	8	—	2	—	—
Found	2.68	9.01	9.81	3.01	2.24	6.07
Guaranteed	1.25	6	—	2	—	—
Found	2.04	8.51	12.62	2.37	0.67	3.47
Guaranteed	2.25	8	—	4	—	—
Found	2.85	8.13	13.16	5.62	1.17	2.98
Guaranteed	1	9	—	2.50	—	—
Found	1.23	8.76	11.39	2.86	0.57	5.64
Below guarantee		0.24				
Guaranteed	2.47	6	8	7	—	—
Found	3.21	5.81	8.47	7.35*	1.39	2.87
Guaranteed	0.82	8	—	3	—	—
Found	1.32	10.31	11.65	2.66	0.21	7.27
Below guarantee				0.34		
Guaranteed	1.50	8	—	2.50	—	—
Found	1.46	10.62	12.10	2.82	0.61	7.52
Guaranteed	0.82	8	—	2	—	—
Found	1.31	8.34	9.69	1.99	0.33	1.72
Guaranteed	3.30	8	—	5	—	—
Found	6.03	10.41	11.86	5.66	3.22	7.68
Guaranteed	2.50	9	—	2	—	—
Found	2.59	8.63	16.62	1.94	2.08	4.18
Below guarantee		0.37				

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number
Preston Fertilizer Co., Brooklyn, N. Y.	Blood and bone.	Poughkeepsie.	3170
Preston Fertilizer Co., Brooklyn, N. Y.	Cabbage and cauliflower.	Jamaica.	3076
Preston Fertilizer Co., Brooklyn, N. Y	Onion fertilizer.	Florida.	3197
Preston Fertilizer Co., Brooklyn, N. Y.	Pioneer.	Poughkeepsie.	3169
Preston Fertilizer Co., Brooklyn, N. Y.	Potato fertilizer.	Jamaica.	3077
Preston Fertilizer Co., Brooklyn, N. Y.	Potato, hop and onion.	Poughkeepsie.	3167
Preston Fertilizer Co., Brooklyn, N. Y.	Pure ground bone.	Glens Falls.	3404
Preston Fertilizer Co., Brooklyn, N. Y.	Soluble bone and potash.	Baldwinsville.	3679
Preston Fertilizer Co., Brooklyn, N. Y.	Special potato manure.	Oneida.	3212
Preston Fertilizer Co., Brooklyn, N. Y.	Ten per cent special.	Jamaica.	3083
Preston Fertilizer Co., Brooklyn, N. Y.	XXV brand.	Poughkeepsie.	3166

lected in New York State During the Fall of 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	4.10	———	18	———	———	———
Found	3.73		18.51		1.20	
Below guarantee	0.37					
Guaranteed	3.25	5	———	7	———	———
Found	2.92	9.17	13.10	5.93*	1.84	4.52
Below guarantee	0.33			1.07		
Guaranteed	3.50	7	———	6	———	———
Found	3.40	8.48	13.88	5.50*	2.14	3.91
Below guarantee				0.50		
Guaranteed	1.50	10	———	1.75	———	———
Found	1.60	9.61	13.80	1.57*	0.69	5.15
Below guarantee		0.39				
Guaranteed	3.25	8	———	7	———	———
Found	2.79	9.48	12.79	6.03*	1.73	4.82
Below guarantee	0.46			0.97		
Guaranteed	2.47	6	———	6	———	———
Found	2.95	5.61	10.73	6.02	1.24	1.37
Below guarantee		0.39				
Guaranteed	3.70	———	20.50	———	———	———
Found	3.94		20.86		1.20	
Guaranteed	———	10	11	1.50	———	———
Found		11.82	12.81	1.79		7.76
Guaranteed	2.50	5	7	5	———	———
Found	2.79	5.06	8.58	5.07	1.22	1.11
Guaranteed	8.20	6	———	4	———	———
Found	5.95	8.31	9.41	4.13	3.28	5.33
Below guarantee	2.25					
Guaranteed	1	8	———	1	———	———
Found	1.03	8.96	10.15	1.95	0.36	5

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Quinnipiac Co., New York City.	Ammoniated dissolved bone.	Varysburg. Fruit Valley.	3376 3705
Quinnipiac Co., New York City.	Climax.	Varysburg. Schuylerville. Newark Valley.	3375 3418 3617
Quinnipiac Co., New York City.	Corn and grain manure.	Southampton.	3152
Quinnipiac Co., New York City.	Dissolved bone and potash.	Schuylerville.	3420
Quinnipiac Co., New York City.	Market garden manure.	Foster's Meadow. Fruit Valley.	3087 3704
Quinnipiac Co., New York City.	Mohawk.	Varysburg. Fruit Valley.	3377 3707
Quinnipiac Co., New York City.	Potato manure.	Southold.	3121
Quinnipiac Co., New York City.	Potato phosphate.	Varysburg. Schuylerville. Fruit Valley.	3378 3419 3706
Quinnipiac Co., New York City.	Special formula.	Bayside.	3092
Quinnipiac Co., New York City.	Special potato.	Webster station.	3743
Quinnipiac Co., New York City.	Uncas bone meal.	North Collins.	3336

LECTED IN NEW YORK STATE DURING THE SPRING OF 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	1.64	9	10	2	——	——
Found	2.02	8.97	12.19	2.07	0.76	3.66
Guaranteed	1.03	8	9	2	——	——
Found	1.15	8.47	11.72	2.95	0.46	2.01
Guaranteed	1.23	8	9	2	——	——
Found	1.30	9.29	11.04	2.12	0.65	4.02
Guaranteed	——	10	11	2	——	——
Found		11.87	15.42	1.97*		5.39
Guaranteed	3.30	8	9	7	——	——
Found	3.25	7.87	11.03	7.10	1	3.75
Guaranteed	0.82	7	8	1	——	——
Found	1.29	8.34	10.24	1.53	0.76	4.18
Guaranteed	2.47	6	7	5	——	——
Found	2.62	5.62	9.17	6.19	0.77	1.51
Below guarantee		0.38				
Guaranteed	2.06	8	9	3	——	——
Found	2.10	9.10	13.40	3.14	0.42	2.73
Guaranteed	3.70	8	——	8	——	——
Found	3.71	8.21	9.41	8.39	2.11	4.83
Guaranteed	1.23	6	——	5	——	——
Found	1.47	6.53	8.26	4.91	0.80	4.06
Guaranteed	1.65	——	13.50	——	——	——
Found	2.20		16.06		0.78	0.31

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Read Fertilizer Co., New York City.	Acid phosphate.	Syracuse.	3666
Read Fertilizer Co., New York City.	Bone meal.	Cortland.	3623
Read Fertilizer Co., New York City.	Bone and potash.	Syracuse.	3670
Read Fertilizer Co., New York City.	Dissolved bone phosphate.	Syracuse.	3663
Read Fertilizer Co., New York City.	Farmer's friend.	Florida. Clarksville. Cortland.	3195 3450 3625
Read Fertilizer Co., New York City.	Fish, bone and potash.	Syracuse.	3664
Read Fertilizer Co., New York City.	High grade farmer's friend.	Unadilla. Syracuse.	3551 3661
Read Fertilizer Co., New York City.	High grade farmer's friend for Long Island.	Mattituck.	3139
Read Fertilizer Co., New York City.	Leader guano.	Clarksville. Syracuse.	3452 3662
Read Fertilizer Co., New York City.	N. Y. State superphosphate.	Syracuse.	3668
Read Fertilizer Co., New York City.	Original alkaline bone.	Syracuse.	3671

lected in New York State During the Spring of 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	———	12	13	———	———	———
Found		12.67	15.24			10.71
Guaranteed	2	———	24	———	———	———
Found	3		25.10		0.97	
Guaranteed	———	8	———	4	———	———
Found		7.90	9.23	4.44		4.69
Guaranteed	———	10	12	———	———	———
Found		10.94	14.42			6.30
Guaranteed	2	9	10	2	———	———
Found	2.22	9.47	10.78	2.27	0.56	6.77
Guaranteed	2.47	4	5	4	———	———
Found	2.66	4.54	6.64	4.36	0.52	2.59
Guaranteed	3.20	5	———	10	———	———
Found	3.35	5.30	7.17	10.48	1.28	3.74
Guaranteed	3.30	7	———	7	———	———
Found	3.67	6.82	9.31	7.27	0.24	4.07
Guaranteed	0.82	7	8	2	———	———
Found	1.14	7.45	8.56	2.49	0.25	4.86
Guaranteed	1.22	9	10	2	———	———
Found	1.49	9.44	10.78	2.25	0.33	6.69
Guaranteed	———	10	11	3	———	———
Found		9.96	11.49	3.15		6.43

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Read Fertilizer Co., New York City.	Potato manure.	Syracuse	3667
Read Fertilizer Co., New York City.	Practical potato special.	Cortland.	3626
Read Fertilizer Co., New York City.	Prime wheat and rye.	Syracuse.	3665
Read Fertilizer Co., New York City.	Pure ground bone.	Clarksville.	3453
Read Fertilizer Co., New York City.	Standard.	Florida. Clarksville. Cortland.	3196 3451 3624
Read Fertilizer Co., New York City.	Vegetable and vine.	Syracuse.	3669
John S. Reese & Co., Baltimore, Md.	Challenge crop grower.	Owego.	3605
John S. Reese & Co., Baltimore, Md.	Columbia "A."	Owego.	3601
John S. Reese & Co., Baltimore, Md.	Crown phosphate and potash.	Fort Edward. Owego.	3408 3606
John S. Reese & Co., Baltimore, Md.	Dissolved phosphate.	Owego.	3607
John S. Reese & Co., Baltimore, Md.	Elm phosphate.	La Grange.	3364

lected in New York State During the Spring of 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	2.47	7	8	10	——	——
Found	2.42	6.85	7.58	10.09	0.88	5.74
Guaranteed	0.82	4	——	8	——	——
Found	1.23	4.50	6.24	8.31	0.33	2.19
Guaranteed	1.64	8	——	4	——	——
Found	1.91	8.27	9.72	4.41	0.81	6.44
Guaranteed	2.50	——	22	——	——	——
Found	3.16		25.79		0.63	
Guaranteed	0.82	8	9	4	——	——
Found	1.04	8.83	9.76	4.10	0.28	5.82
Guaranteed	1.64	6	——	8	——	——
Found	1.94	6.65	7.96	8.04	0.52	4.79
Guaranteed	0.82	8	——	2	——	——
Found	0.91	10.79	12.13	2.54	0.49	
Guaranteed	3.29	7	——	9.50	——	——
Found	3.21	8	9.51	9.28	1.59	5.54
Below guarantee				0.22		
Guaranteed	——	12	——	2	——	——
Found		13.28	14.46	1.65		3.59
Below guarantee				0.35		
Guaranteed	——	14	——	——	——	——
Found		15.91	16.88			7.83
Guaranteed	——	14	——	——	——	——
Found		14.97	16.21			10.60

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
John S. Reese & Co., Baltimore, Md.	Pilgrim fertilizer.	Fort Edward. Owego.	3410 3604
John S. Reese & Co., Baltimore, Md.	Potato phosphate.	Owego.	3603
John S. Reese & Co., Baltimore, Md.	Potato special.	Fort Edward. Owego.	3409 3602
Jas. L. Reynolds Co., Mount Vernon, N. Y.	Bone.	Mount Vernon.	3164
Jas. L. Reynolds Co., Mount Vernon, N. Y.	Complete fertilizer.	Mount Vernon.	3165
Riverside Acid Works, Warren, Pa.	Grape and fruit special.	Silver Creek.	3265
Riverside Acid Works, Warren, Pa.	Harvest moon No. 1.	Silver Creek.	3257
Riverside Acid Works, Warren, Pa.	Harvest moon No. 2.	Silver Creek.	3264
Riverside Acid Works, Warren, Pa.	Rich acre.	Silver Creek.	3256
Rochester Fertilizer Works, Rochester, N. Y.	Blood and bone guano.	Rochester.	3584
Rochester Fertilizer Works, Rochester, N. Y.	Genesee guano.	Rochester.	3585

lected in New York State During the Spring of 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	1.23	6.50	7.50	3	—	—
Found	1.35	8.57	10.17	2.87	0.45	2.13
Guaranteed	2.06	8.50	—	6	—	—
Found	2.75	6.89	8.55	7.37*	1	4.03
Below guarantee		1.61				
Guaranteed	2.88	6.50	—	7.50	—	—
Found	2.70	8.14	8.84	8.18	1.20	
Guaranteed	3	—	12	—	—	—
Found	4.04		17.94		1.24	0.20
Guaranteed	3.25	3.50	—	8	—	—
Found	3.24	6	12.97	7.99	1.68	
Guaranteed	0.82	9	10	5.50	—	—
Found	1.19	9.10	12.97	3.96*	0.06	6.39
Below guarantee				1.54		
Guaranteed	2.10	7	8.75	1.10	—	—
Found	1.76	8.67	8.67	1.48*	0.01	6.53
Below guarantee	0.34					
Guaranteed	2.10	7	7.75	1.10	—	—
Found	1.72	8.12	12.08	1.21*	0.08	3.08
Below guarantee	0.38					
Guaranteed	2.50	8	8.75	1.25	—	—
Found	2.16	9.32	9.93	1.61*	0.03	6.33
Below guarantee	0.34					
Guaranteed	0.82	8	—	1.62	—	—
Found	0.75	8.76	10.26	2.69*	0.09	4.42
Guaranteed	1.65	8	—	3.25	—	—
Found	1.67	9.68	11.70	3.98*	0.10	5.29

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Rochester Fertilizer Works, Rochester, N. Y.	Potato manure.	Rochester.	3587
Rochester Fertilizer Works, Rochester, N. Y.	Vegetable phosphate.	Rochester.	3586
Lucien Sanderson, New Haven, Conn.	Early cabbage fertilizer.	Jamaica.	3068
Lucien Sanderson, New Haven, Conn.	Formula "A."	Jamaica.	3069
Geo. Schaal, Erie, Pa.	Erie City corn and potato.	Westfield.	3259
Geo. Schaal, Erie, Pa.	Special grape.	Westfield.	3260
Scheid & Fechter, East Buffalo, N. Y.	East star.	Morton's Corners.	3321
Sharpless & Carpenter, Philadelphia, Pa.	Gilt-edged potato manure.	Queens.	3101
M. L. Shoemaker & Co., Philadelphia, Pa.	Bone meal.	Southampton.	3151
M. L. Shoemaker & Co., Philadelphia, Pa.	Superphosphate for potatoes.	Southampton.	3149
W. H. Stamp, Warsaw, N. Y.	Farmer's pride.	Warsaw.	3368

LECTED IN NEW YORK STATE DURING THE SPRING OF 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	2.87	8	——	5.40	——	——
Found	2.66	8.37	11.31	4.33*	0.20	4.78
Below guarantee	0.21			1.07		
Guaranteed	0.41	8	——	8	——	——
Found	0.48	8.43	9.78	7.60*	0.16	4.18
Below guarantee				0.40		
Guaranteed	4	5	8	5	——	——
Found	3.84	5.04	8.68	6.42	2.50	1.63
Guaranteed	3.30	7	10	6	——	——
Found	3.35	6.59	10.22	6.96	1.90	2.16
Below guarantee		0.41				
Guaranteed	2.47	9	——	4	——	——
Found	2.17	7.01	10.38	4.02	0.40	2.94
Below guarantee	0.30	1.99				
Guaranteed	1.65	——	9	19	——	——
Found	1.52	6.35	8.86	10.68	0.31	2.41
Below guarantee				8.32		
Guaranteed	4.89	6.85	12.45	1.13	——	——
Found	4.97	4.64	9.33	0.95	1.63	
Below guarantee		2.21				
Guaranteed	2.47	7	——	6	——	——
Found	2.62	7.03	10.13	6.06	0.49	2.88
Guaranteed	4.10	——	20	——	——	——
Found	5.28		22.54		1.19	
Guaranteed	2.47	8	11	6	——	——
Found	2.49	11.30	13.19	7.23	1.55	7.35
Guaranteed	0.80	8	——	2	——	——
Found	1.11	9.44	10.30	2.15	0.58	0.29

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
W. H. Stamp, Warsaw, N. Y.	Wheat special.	Warsaw.	3369
Standard Fertilizer Co., Boston, Mass.	"A" brand.	Angola. Voorheesville. Mexico.	3278 3455 3716
Standard Fertilizer Co., Boston, Mass.	Ammoniated dissolved bone.	Mexico.	3714
Standard Fertilizer Co., Boston, Mass.	Complete manure.	Bridgehampton. Canajoharie. Canastota.	3144 3514 3740
Standard Fertilizer Co., Boston, Mass.	Dissolved bone phosphate.	Voorheesville.	3454
Standard Fertilizer Co., Boston, Mass.	Empire State.	Bridgehampton. Canastota.	3143 3739
Standard Fertilizer Co., Boston, Mass.	Guano.	Mattituck. Chester. Schoharie.	3133 3192 3580
Standard Fertilizer Co., Boston, Mass.	Potato and tobacco fertilizer.	Fonda. Mexico.	3494 3717
Standard Fertilizer Co., Boston, Mass.	Standard fertilizer.	Albany. Johnstown. Canastota.	3449 3499 3741
H. Stappenbeck, Utica, N. Y.	Bone meal.	Utica.	3519
H. Stappenbeck, Utica, N. Y.	Home trade bone superphosphate.	Utica. Madison Center.	3518 3744

lected in New York State During the Spring of 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	0.80	10	——	4	——	——
Found	1.05	11	11.64	3.63	0.55	0.81
Below guarantee				0.37		
Guaranteed	0.82	7	9	1	——	——
Found	1.03	8.24	9.69	1.30	0.25	5.65
Guaranteed	1.65	9	10	2	——	——
Found	2.23	8.50	10.44	2.73	0.49	6.79
Below guarantee		0.50				
Guaranteed	3.30	8	9	7	——	——
Found	3.28	8.71	10.69	6.95	1.34	4.85
Guaranteed	——	10	12	——	——	——
Found		11.07	12.46			8.49
Guaranteed	0.82	4	——	8	——	——
Found	1.67	7.18	9.31	7.22	0.98	3.17
Below guarantee				0.78		
Guaranteed	1.03	8	10	2	——	——
Found	1.28	8.68	11.36	2.10	0.64	4.08
Guaranteed	2	8	9	3	——	——
Found	2.10	8.40	10.16	3.39	0.30	5.61
Guaranteed	2	8	10	2	——	——
Found	2.82	9.09	10.50	2.41	2.17	3.75
Guaranteed	3.30	——	19	——	——	——
Found	3.44		23.40		2.10	0.40
Guaranteed	2.05	10	——	2	——	——
Found	2.20	10.94	11.95	2.82	0.98	7.96

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
H. Stappenbeck, Utica, N. Y.	Hop, fruit and vegetable special.	Utica.	3520
Swift & Co., Chicago, Ill.	Bone tankage and potash.	Cuba.	3293
Swift & Co., Chicago, Ill.	No. 1 ground tankage.	Carthage.	3783
Swift & Co., Chicago, Ill.	Pure bone and potash.	Cuba. Oneonta.	3292 3569
Swift & Co., Chicago, Ill.	Pure bone tankage.	Franklinville.	3298
Swift & Co., Chicago, Ill.	Pure ground steamed bone.	Oneonta. Carthage.	3570 3782
Swift & Co., Chicago, Ill.	Pure raw bone meal.	Fredonia. Oneonta. Carthage.	3233 3568 3784
I. P. Thomas & Son, Philadelphia, Pa.	Improved superphosphate.	Colosse.	3719
I. P. Thomas & Son, Philadelphia, Pa.	Normal bone phosphate.	Greenbush.	3444
I. P. Thomas & Son, Philadelphia, Pa.	S. C. phosphate.	Colosse.	3718
E. D. Tolles, Attica, N. Y.	Animal bone.	Attica.	3358

LECTED IN NEW YORK STATE DURING THE SPRING OF 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	2.05	9	———	6	———	———
Found	2.08	10.37	12.02	9.13*	0.98	2.50
Guaranteed	5	———	16.75	3	———	———
Found	4.36	8.36	16.74	4.22*	0.56	
Below guarantee	0.64					
Guaranteed	7.40	———	6	———	———	———
Found	7.94		9.40		0.55	0.47
Guaranteed	2	———	24.50	3	———	———
Found	2.52	7.88	25.49	3.07	0.40	
Guaranteed	5	———	17	———	———	———
Found	5.31		18.33		0.59	
Guaranteed	3.25	———	23.75	———	———	———
Found	3.16		27.04		0.31	
Guaranteed	3.25	———	23	———	———	———
Found	4.13		24.30		0.38	
Guaranteed	0.82	10	12	1	———	———
Found	0.80	10.70	12.48	1.52	0.38	7.97
Guaranteed	1	8.50	9.50	1.50	———	———
Found	0.92	8.49	10.30	1.71	0.11	4.52
Guaranteed	———	13	15	———	———	———
Found		15.08	16.80			10.90
Guaranteed	1.85	9	13.50	4	———	———
Found	2.06	9.70	13.33	4.43	0.79	6.97

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
E. D. Tolles, Attica, N. Y.	Barnyard manure.	Attica.	3356
E. D. Tolles, Attica, N. Y.	Dissolved bone phosphate.	Attica.	3354
E. D. Tolles, Attica, N. Y.	Guano.	Attica.	3357
E. D. Tolles, Attica, N. Y.	Potato manure.	Attica.	3355
E. Tuthill & Co., Promised Land, N. Y.	Riverhead Town club fertilizer.	Riverhead.	3129
E. Tuthill & Co., Promised Land, N. Y.	Southold Town club fertilizer.	Southold.	3122
E. Tuthill & Co., Promised Land, N. Y.	Special potato fertilizer.	East Williston.	3098
E. Tuthill & Co., Promised Land, N. Y.	W. & L. B. Young fertilizer.	Riverhead.	3130
Tygert-Allen Fertilizer Co., Philadelphia, Pa.	Cabbage manure.	Flatbush.	3106
Tygert-Allen Fertilizer Co., Philadelphia, Pa.	Dissolved S. C. phosphate.	Southold.	3123
Tygert-Allen Fertilizer Co., Philadelphia, Pa.	Potato manure.	Flatbush. Bridgehampton.	3107 3148

LECTED IN NEW YORK STATE DURING THE SPRING OF 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	0.82	8	——	4	——	——
Found		8.75	10.41	4.06	0.59	6.54
Guaranteed	——	15	——	——	——	——
Found		15.88	16.37			11.60
Guaranteed	1.85	9	——	4	——	——
Found	1.87	9.54	10.80	4.31	0.96	6.84
Guaranteed	2.47	7	——	8	——	——
Found	2.25	8.03	9.22	6.89	0.83	5.44
Below guarantee	0.22			1.11		
Guaranteed	4	8	——	10	——	——
Found	3.72	8.28	9.75	9.78	1.65	6.03
Below guarantee	0.28			0.22		
Guaranteed	4	8	——	10	——	——
Found	3.99	8.15	10	10.43	1.21	5.51
Guaranteed	4	8	——	10	——	——
Found	4.26	7.57	9.70	9.23	1.10	5.48
Below guarantee		0.43		0.77		
Guaranteed	3.30	8	——	10	——	——
Found	2.97	7.84	10.02	11.08	0.57	5.63
Below guarantee	0.33					
Guaranteed	3.30	7	9	5	——	——
Found	3.63	7.64	9.30	6.67	2.48	5.89
Guaranteed	——	12	13	——	——	——
Found		15.43	16.75			12.05
Guaranteed	3.30	6	9	9	——	——
Found	3.34	6.98	8.61	8.95	2.47	5.45

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
F. G. Underwood, Oneida, N. Y.	Special pea fertilizer.	Oneida.	3211
F. G. Underwood, Oneida, N. Y.	Underwood fertilizer.	Oneida.	3210
M. E. Wheeler & Co., Rutland, Vt.	Corn fertilizer.	Dunkirk. Phœnix. Caughdenoy.	3270 3693 3736
M. E. Wheeler & Co., Rutland, Vt.	Electrical dissolved bone.	Franklinville. Tully.	3297 3660
M. E. Wheeler & Co., Rutland, Vt.	Fruit fertilizer.	West Winfield.	3528
M. E. Wheeler & Co., Rutland, Vt.	Grass and oats.	Dunkirk.	3269 3659
M. E. Wheeler & Co., Rutland, Vt.	High grade Orleans Co. bean manure.	Franklinville.	3296
M. E. Wheeler & Co., Rutland, Vt.	Potato manure.	Varysburg. West Winfield. Phœnix.	3374 3526 3694
M. E. Wheeler & Co., Rutland, Vt.	Superior rye and oats fertilizer.	Johnstown.	3500
M. E. Wheeler & Co., Rutland, Vt.	Royal wheat grower.	Varysburg. West Winfield.	3373 3527
Wilkinson & Co., Buffalo, N. Y.	Economical bone fertilizer.	Cornwall.	3187

lected in New York State During the Spring of 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds o available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	1	7	——	8.50	——	——
Found	2.07	6.72	10.44	10.43	1.03	3.12
Below guarantee		0.28				
Guaranteed	2.60	7	——	7	——	——
Found	2.78	6.97	10.41	8.83	1.39	3.19
Guaranteed	1.64	8	9	2	——	——
Found	1.95	8.94	10.83	2.46	0.67	6.16
Guaranteed	——	13	15	——	——	——
Found		15.79	16.66			7.55
Guaranteed	——	10	12	8	——	——
Found		11.07	11.61	8.59		7.84
Guaranteed	——	11	12	2	——	——
Found		13.22	13.67	2.26		6.06
Guaranteed	0.82	8	——	4	——	——
Found	1.03	8.96	9.88	4.23	0.62	7.29
Guaranteed	2.05	8	9	3.25	——	——
Found	2.56	8	10.81	3.66	0.77	5.47
Guaranteed	0.82	8	9	2	——	——
Found	1.14	9.16	10.85	2	0.32	5.64
Guaranteed	0.82	8	9	2	——	——
Found	1.03	8.67	9.64	2.42	0.79	6.41
Guaranteed	1.23	7	8	3	——	——
Found	1.48	6.82	9.64	3.70	0.72	4.69

Results of Analyses of Commercial Fertilizers Col-

Manufacturer.	Trade name or brand.	Locality where sample was taken	Station number.
Williams & Clark Fertilizer Co., New York City.	Acorn acid phosphate.	Brant. New Scotland.	3329 3459
Williams & Clark Fertilizer Co., New York City.	Ammoniated bone superphosphate.	White Plains. Kingston.	3161 3208
Williams & Clark Fertilizer Co., New York City.	Ammoniated dissolved bone.	Amsterdam. Williamstown.	3483 3756
Williams & Clark Fertilizer Co. New York City.	Ammoniated bone phosphate.	West Winfield.	3525
Williams & Clark Fertilizer Co. New York City.	Carteret bone meal.	Amsterdam.	3482
Williams & Clark Fertilizer Co., New York City.	Carteret bone meal with potash.	Saratoga.	3390
Williams & Clark Fertilizer Co., New York City	Dissolved bone and potash.	Brant. Attica. Williamstown.	3328 3359 3755
Williams & Clark Fertilizer Co., New York City.	Good grower potato phosphate.	New Scotland. Lycoming.	3460 3708
Williams & Clark Fertilizer Co. New York City.	High grade special.	White Plains. Cobleskill.	3162 3579
Williams & Clark Fertilizer Co. New York City.	Potato, hop and tobacco manure.	Sidney.	3549
Williams & Clark Fertilizer Co., New York City.	Prolific crop producer.	Brant. New Scotland.	3327 3461

LECTED IN NEW YORK STATE DURING THE SPRING OF 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed Found	———	13 14.84	14 15.95	———	———	——— 11.43
Guaranteed Found	2.50 2.64	9 8.87	10 11.77	2 2.19	——— 1.16	——— 4.83
Guaranteed Found	1.64 1.81	8 10.86	9 13.41	2 2.01	——— 0.62	——— 3.69
Guaranteed Found	1.64 2.82	8 8.99	9 11.86	2 2.15	——— 1.41	——— 4.25
Guaranteed Found	1.65 1.91	———	14 12.28	———	——— 0.30	——— 2.84
Guaranteed Found	1.65 2.19	——— 4.16	11 12.63	3 3.14	——— 0.32	——— 0.80
Guaranteed Found	———	10 11.22	14 15.38	2 2.12	———	——— 8.02
Guaranteed Found	1.23 1.50	6 6.78	7 8.62	5 5.31	——— 0.76	——— 3.70
Guaranteed Found	3.71 3.61	7 8.20	8 10.78	7 6.99	——— 1.59	——— 3.83
Guaranteed Found	2.06 2.48	8 8.27	9 12.43	3 3.07	——— 0.90	——— 3.12
Guaranteed Found	0.82 1.05	6 8.34	7 10.11	1 1.24	——— 0.61	——— 3.88

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Williams & Clark Fertilizer Co., New York City.	Pure bone meal.	Amsterdam.	3481
Williams & Clark Fertilizer Co., New York City.	Royal bone phosphate.	Otto. Amsterdam. Williamstown.	3287 3480 3757
Williams & Lander, Ardsley, N. Y.	[Not given.]	Ardsley.	3163
William Woolett, Gloversville, N. Y.	Bone and meat.	Gloversville.	3513
Zell Guano Co., Baltimore, Md.	Ammoniated bone superphosphate.	Solsville.	3547
Zell Guano Co., Baltimore, Md.	Calvert guano.	Johnsonburg.	3380
Zell Guano Co., Baltimore, Md.	Dilman Bros. special.	Geneva.	3342
Zell Guano Co., Baltimore, Md.	Dissolved bone phosphate.	East Rush.	3341
Zell Guano Co., Baltimore, Md.	Electric phosphate.	Johnsonburg.	3379
Zell Guano Co., Baltimore, Md.	High grade cabbage manure.	Geneva.	3344
Zell Guano Co., Baltimore, Md.	High grade celery manure.	Geneva.	3343

LECTED IN NEW YORK STATE DURING THE SPRING OF 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	2.47	——	20	——	——	——
Found	2.78		20.63		0.41	0.85
Guaranteed	1.25	7	8	2	——	——
Found	1.29	8.05	11.84	1.86	0.43	1.64
Guaranteed	——	——	——	——	——	——
Found	2.38	2.14	3.66	0.26	1.16	
Guaranteed	4.30	——	13.30	——	——	——
Found	2.18		9.89		1.26	1.55
Below guarantee	2.12		3.41			
Guaranteed	1.60	8	10	2	——	——
Found	1.61	9.89	12.64	2.22	0.63	6.03
Guaranteed	0.60	9	11	1.50	——	——
Found	0.92	10.68	12.37	1.55	0.29	7.94
Guaranteed	2.45	7	8	15	——	——
Found	2.65	7.84	8.85	13.50	2	6.42
Below guarantee				1.50		
Guaranteed	——	14	15	——	——	——
Found		15.21	16.66			12.47
Guaranteed	——	10	12	2	——	——
Found		9.80	14.94	2.38		1.22
Guaranteed	4.10	6	8	6	——	——
Found	4.20	6.43	9.49	6.30	2.12	3.42
Guaranteed	3.25	5	7	9	——	——
Found	3.49	6.67	9.63	9.19	1.96	2.87

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Zell Guano Co., Baltimore, Md.	High grade potato manure.	Perry Center.	3363
Zell Guano Co., Baltimore, Md.	Special compound for potatoes and vegetables.	Solsville.	3548
Zell Guano Co., Baltimore, Md.	Special high grade potato and cabbage manure.	East Rush.	3340
Zell Guano Co., Baltimore, Md.	Spring meadow special.	Oswego.	3613

LECTED IN NEW YORK STATE DURING THE SPRING OF 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	3.25	6	8	8	———	———
Found	2.60	6.81	9.94	9.85	0.69	2.93
Below guarantee	0.65					
Guaranteed	2.45	8	10	4	———	———
Found	2.48	10.87	11.86	4.49	1.71	8.91
Guaranteed	2.45	7	9	8	———	———
Found	2.63	7.48	10.40	7.84	1.43	2.94
Guaranteed	2.45	7	9	8	———	———
Found	2.64	8	11.60	7.90	1.53	3.49

II. REPORT OF ANALYSES OF COMMERCIAL FERTILIZERS FOR THE FALL OF 1897.*

L. L. VAN SLYKE.

SUMMARY.

(1) Samples collected. During the fall of 1897, the Station collected 270 samples of commercial fertilizers, representing 248 different brands. Of these different brands 172 were complete fertilizers; of the others, 38 contained phosphoric acid and potash without nitrogen; 7 contained nitrogen and phosphoric acid without potash; 28 contained phosphoric acid alone; and 2 contained potash salts only.

(2) Nitrogen. The 172 brands of complete fertilizers contained nitrogen varying in amounts from 0.58 to 4.89 per cent and averaging 1.69 per cent. The average amount of nitrogen found by the Station analysis exceeded the average guaranteed amount by 0.16 per cent, the guaranteed average being 1.53 per cent and the average found being 1.69 per cent.

In 144 brands of complete fertilizers, the amount of nitrogen found was equal to or above the guaranteed amount, the excess varying from 0.01 to 0.93 per cent and averaging 0.22 per cent.

In 28 brands, the nitrogen was below the guaranteed amount, the deficiency varying from 0.01 to 0.96 per cent and averaging 0.21 per cent. In 25 cases, the deficiency was less than 0.5 per cent.

The amount of water-soluble nitrogen varied from 0.01 to 3.81 per cent and averaged 0.58 per cent.

(3) Available phosphoric acid. The 172 brands of complete fertilizers contained available phosphoric acid varying in amount from 3.81 to 12.78 per cent and averaging 9.22 per cent. The

* Reprint of Bulletin No. 134.

average amount of available phosphoric acid found by the Station analysis exceeded the average guaranteed amount by 0.70 per cent, the guaranteed average being 8.52 per cent and the average found being 9.22 per cent.

In 136 brands of complete fertilizers, the amount of available phosphoric acid found was above the amount guaranteed, the excess varying from 0.02 to 3.85 per cent and averaging 1.01 per cent.

In 36 brands, the available phosphoric acid was below the guaranteed amount, the deficiency varying from 0.01 to 1.86 per cent and averaging 0.40 per cent. In 26 cases the deficiency was below 0.5 per cent.

The amount of water-soluble phosphoric acid varied from 0.65 to 9.08 per cent and averaged 5.75 per cent.

(4) Potash. The complete fertilizers contained potash varying in amount from 0.58 to 16.52 per cent and averaging 3.92 per cent. The average amount of potash found by the Station analysis exceeded the average guaranteed amount by 0.18 per cent, the guaranteed average being 3.74 per cent and the average found being 3.92 per cent.

In 118 brands of complete fertilizers, the amount of potash found was above the guaranteed amount, the excess varying from 0.01 to 3.59 per cent and averaging 0.46 per cent.

In 51 brands, the potash was below the guaranteed amount, the deficiency varying from 0.01 to 1.74 per cent and averaging 0.46 per cent. In 33 of these cases, the deficiency was less than 0.5 per cent.

In 18 cases among the 172 brands of complete fertilizers the potash was contained in the form of sulphate free from an excess of chlorides.

(5) The retail selling price of the complete fertilizers varied from $15 to $40 a ton and averaged $25.25. The retail cost of the separate ingredients unmixed varied from $11.26 to $29.28 and averaged $18.92, or $6.33 less than the selling price.

INTRODUCTION.

NUMBER AND KINDS OF FERTILIZERS COLLECTED.

During the entire year of 1897, we collected 1,005 samples of commercial fertilizers, representing 748 different brands. It is a matter of interest to notice to what extent dealers offer for sale complete fertilizers (those containing nitrogen, phosphoric acid and potash), compared with those containing only one or two of these ingredients. It is also of interest to consider the different forms in which incomplete fertilizers are offered for sale. The following tabulated statement indicates the different kinds of complete and incomplete fertilizers collected during the year.

CLASSES OF FERTILIZERS COLLECTED IN 1897.

1897.	Brands containing only nitrogen.	Brands containing only phosphoric acid.	Brands containing only potash.	Brands containing nitrogen and phosphoric acid without potash.	Brands containing potash and phosphoric acid without nitrogen.	Brands of complete commercial fertilizers.
Spring collection	0	31	3	33	32	400
Fall collection	1	28	2	7	38	172
Total for year	1	59	5	40	70	572

In the spring collection, 80 per cent of the brands offered for sale consisted of complete fertilizers; in the fall, 69.3 per cent; and, during the year, an average of 76.5 per cent. Of unmixed materials, phosphoric acid was offered much more largely than nitrogen or potash, the average for the year being about 10.5 per cent of all brands offered. A smaller number containing phosphoric acid and nitrogen was found. It will be seen that the mixture of phosphoric acid and potash was quite largely used, averaging for the year over 12 per cent of all the brands collected.

COMPOSITION OF FERTILIZERS COLLECTED IN 1897.

The tabulated statement below shows the average composition of the complete fertilizers collected during the year, together with a comparison of the guaranteed composition and that found by analysis.

AVERAGE COMPOSITION OF COMPLETE FERTILIZERS COLLECTED.

	PER CENT GUARANTEED.			PER CENT FOUND.			Average per cent found above guarantee.
	Lowest.	Highest.	Average.	Lowest.	Highest.	Average.	
Spring:							
Nitrogen	0.40	8.78	2.09	0.30	8.08	2.23	0.14
Available phosphoric acid ..	1.93	0.11	7.63	0.83	19.68	8.44	0.81
Insoluble phosphoric acid ...	....	....	....	0.10	8.06	2.19	....
Potash	0.14	19.00	4.30	0.08	15.58	4.57	0.27
Water-soluble phosphoric acid	....	....	....	0.01	6.25	0.95	....
Water-soluble nitrogen	....	....	....	0.20	12.47	4.97	....
Fall:							
Nitrogen	0.41	5.00	1.53	0.58	4.89	1.69	0.16
Available phosphoric acid ...	3.00	11.00	8.52	3.81	12.78	9.22	0.70
Insoluble phosphoric acid....	....	....	....	0.31	8.59	2.16	....
Potash	1.00	15.00	3.74	0.58	16.52	3.92	0.18
Water-soluble phosphoric acid	....	....	....	0.01	3.81	0.58	....
Water-soluble nitrogen	....	....	....	0.65	9.08	5.75	....
Average for year:							
Nitrogen	....	....	1.92	....	....	2.07	0.15
Available phosphoric acid...	....	....	7.90	....	....	8.67	0.77
Insoluble phosphoric acid...	....	....	....	....	....	2.18	....
Potash	....	....	4.13	....	....	4.37	0.24
Water-soluble phosphoric acid	....	....	....	....	....	0.84	....
Water-soluble nitrogen	....	....	....	....	....	5.20	....

In the following tabulated statement we give the composition of the different kinds of incomplete fertilizers included in our year's collection.

AVERAGE COMPOSITION OF INCOMPLETE FERTILIZERS COLLECTED.

CHEMICALS AND INCOMPLETE FERTILIZERS.	PER CENT GUARANTEED.			PER CENT FOUND.			Average per cent found above guarantee.
	Lowest.	Highest.	Average.	Lowest.	Highest.	Average.	
Nitrogen in							
Dried blood	12.35	12.35	12.35	13.49	13.49	13.49	1.14
Phosphoric acid in dissolved phosphates:							
Available	10	16	13.18	10.88	17.32	14.27	1.09
Insoluble.........	....	....	....	0.36	4.78	2.05	....
Water-soluble ..	....	....	....	3.39	12.50	9.45	....
Potash in							
Kainit...........	11	12	11.67	11.49	14.58	12.74	1.07
Muriate..........	50	50	50	49.36	50.84	50.10	0.10
Bone meal and tankage:							
Nitrogen	1.35	8.20	3.24	1.34	7.94	3.57	0.35
Phosphoric acid.	6.	25	18.50	9.40	30.09	20.28	1.78
Mixtures containing phosphoric acid:							
Available........	5	13	10.10	6.15	15.33	11.05	0.95
Insoluble	....	....	....	0.07	6.22	2.01	....
Water-soluble...	....	....	....	0.99	12.19	6.25	....
Potash............	1	10	3.38	1.09	9.94	3.42	0.04

COMPARISON OF SELLING PRICE AND COMMERCIAL VALUATION.

Giving to the different constituents the values assigned in the schedule on page 36 for mixed fertilizers, 14 cents a pound for nitrogen, 5½ cents a pound for water-soluble phosphoric acid, 5 cents a pound for citrate-soluble phosphoric acid, 2 cents a pound for insoluble phosphoric acid, and 4½ cents a pound for potash, we can calculate the commercial valuation, or the price at which the separate unmixed materials contained in one ton of fertilizer having the composition indicated in the preceding table, could be purchased for cash at retail at the seaboard. Knowing the retail prices at which these goods were offered for sale, we can also readily estimate the difference between the actual selling price of the mixed goods and the retail cash cost of the unmixed materi-

als; the difference covers the cost of mixing, freight, profits, etc. We present these data in the following table, including only complete fertilizers.

COMMERCIAL VALUATION AND SELLING PRICE OF COMPLETE FRTILIZERS.

1897.	Commercial Valuation of Complete Fertilizers.			Selling Price of One Ton of Complete Fertilizer.			Average increased cost of mixed materials over unmixed materials for one ton.
	Lowest.	Highest.	Average.	Lowest.	Highest.	Average.	
Spring	$1 80	$34 25	$20 17	$15 00	$60 00	$28 92	$8 75
Fall	11 26	29 28	18 92	15 00	40 00	25 25	6 33
Average for year,	....	....	$19 75	....	....	$27 70	$7 95

In the following tabulated statement, we give a comparison of the selling price and commercial valuation for the various incomplete fertilizers collected during the year, using the prices given in the schedule on page 36 as our basis of calculation.

COMMERCIAL VALUATION AND SELLING PRICE OF INCOMPLETE FERTILIZERS.

CHEMICALS AND INCOMPLETE FERTILIZERS.	Commercial Valuation.			Selling Price.			Average increase of selling price over commercial valuation.
	Lowest.	Highest.	Average.	Lowest.	Highest.	Average.	
Dissolved phosphates............	$12 43	$19 27	$15 90	$11 00	$26 50	$16 40	$0 50
Kainit.............	10 34	13 12	11 47	12 00	15 00	14 00	2 53
Muriate of potash..	44 42	45 79	45 10	38 00	40 00	39 00	*6 10
Bone-meal and tankage...............	16 00	36 80	29 74	20 00	50 00	28 55	*1 19
Mixtures containing phosphoric acid and potash......	9 02	22 43	15 58	13 00	32 00	21 04	5 46

*Selling price less than commercial valuation.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Armour Fertilizer Co., Chicago, Ill.	Ammoniated bone with potash.	Akron.	4048
Armour Fertilizer Co., Chicago, Ill.	Bone meal.	Akron.	4047
H. J. Baker & Bro., New York City.	Superphosphate of lime.	Weedsport.	3956
Bowker Fertilizer Co., Boston, Mass.	A. B. C. special.	Port Byron.	3999
Bowker Fertilizer Co., Boston, Mass.	Alkaline bone.	Gorham. Newark.	3865 3988
Bowker Fertilizer Co., Boston, Mass.	Baldridge's Seneca queen.	MacDougall.	3915
Bowker Fertilizer Co., Boston, Mass.	Baldridge's Seneca County special.	MacDougall.	3914
Bowker Fertilizer Co., Boston, Mass.	Chemung Valley special.	Horseheads.	3944
Bowker Fertilizer Co., Boston, Mass.	Colgrove & Vann wheat special.	Willow Creek.	3878
Bowker Fertilizer Co., Boston, Mass.	Dissolved bone.	Wolcott.	3967
Bowker Fertilizer Co., Boston, Mass.	Grangers' special.	Clyde.	3992

lected in New York State During the Fall of 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	2.47	8	10	1.50	——	——
Found	3.09	9.49	12.43	3.80	0.76	5.43
Guaranteed	2.47	11	25	——	——	——
Found	3.13	10.64	25.95		0.39	
Guaranteed	——	11	——	——	——	——
Found		14.41	14.77			11.92
Guaranteed	2.47	7	——	15	——	——
Found	2.22	6.59	10.19	16.52	1.43	3.16
Below guarantee	0.25	0.41				
Guaranteed	——	11	——	1	——	——
Found		10.86	17.08	1.20		4.74
Guaranteed	——	14	——	——	——	——
Found		14	17.07			6.49
Guaranteed	0.75	10	——	4	——	——
Found	0.99	11.37	12.64	4.11	0.08	7.39
Guaranteed	2.25	7	——	8	——	——
Found	2.48	8.52	10.65	7.93	0.81	5.90
Guaranteed	0.75	8	——	4	——	——
Found	0.91	9.48	11.63	4.31	0.32	5.63
Guaranteed	——	13	15	——	——	——
Found		14.06	17.36			7.73
Guaranteed	0.82	8	10	4	——	——
Found	1.31	8.96	12.51	5.11	0.44	3.04

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Bowker Fertilizer Co., Boston, Mass.	Groveland special No. 2 for beans.	North Sparta.	4028
Bowker Fertilizer Co., Boston, Mass.	High grade wheat fertilizer.	North Sparta.	4027
Bowker Fertilizer Co., Boston, Mass.	Hopkins' special.	Canandaigua.	3949
Bowker Fertilizer Co., Boston, Mass.	Humphrey & Holdridge best grain phosphate.	Honeoye Falls.	3900
Bowker Fertilizer Co., Boston, Mass.	Humphrey & Holdridge best grain phosphate.	Honeoye Falls.	3902
Bowker Fertilizer Co., Boston, Mass.	Humphrey & Holdridge cabbage manure.	Honeoye Falls.	3898
Bowker Fertilizer Co., Boston, Mass.	Humphrey & Holdridge dissolved bone phosphate.	Honeoye Falls.	3901
Bowker Fertilizer Co., Boston, Mass.	Humphrey & Holdridge standard phosphate.	Honeoye Falls.	3897
Bowker Fertilizer Co., Boston, Mass.	Kinne's selected fertilizer.	Ovid.	3887
Bowker Fertilizer Co., Boston, Mass.	Potato manure.	Alton.	3978
Bowker Fertilizer Co., Boston, Mass.	Soluble bone.	Honeoye Falls. Penn Yan. Clyde.	3899 3939 3991

lected in New York State During the Fall of 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	0.75	7	9	9	—	—
Found	0.97	8.28	10.83	9.29	0.41	4.88
Guaranteed	1.50	10	12	5	—	—
Found	1.83	10.82	13.25	5.61*	0.75	6.60
Guaranteed	1	10	11	4	—	—
Found	1.21	10.25	12.41	4.25	0.57	7.52
Guaranteed	1.23	10	—	6	—	—
Found	1.27	11.19	13.26	5.63	0.25	8.56
Below guarantee				0.37		
Guaranteed	1	10	—	6	—	—
Found	1.35	11.04	13.08	5.65	0.12	6.74
Below guarantee				0.35		
Guaranteed	2.25	7	—	8	—	—
Found	2.57	7.54	10.99	7.64	0.67	3.95
Below guarantee				0.36		
Guaranteed	—	14	—	—	—	—
Found		14.52	16.57			12.50
Guaranteed	1	10	—	3	—	—
Found	1.36	10.83	12.88	2.82	0.09	7.54
Guaranteed	1	9	—	2.50	—	—
Found	1.31	10.18	12.28	2.86	0.41	6.50
Guaranteed	2.25	8	10	4	—	—
Found	2.10	9.07	13.31	4.28	0.89	5.03
Guaranteed	—	14	—	—	—	—
Found.		14.48	17.22			5.48

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Bowker Fertilizer Co., Boston, Mass.	Special ammoniated bone.	Cato.	3962
Bowker Fertilizer Co., Boston, Mass.	Square brand bone and potash.	Port Byron.	4000
Bowker Fertilizer Co., Boston, Mass.	Stockbridge vine, squash, etc.	Port Byron.	3998
Bowker Fertilizer Co., Boston, Mass.	Yates' special.	Farmer.	3884
Bradley Fertilizer Co., Boston, Mass.	Alkaline bone.	Lockville.	3987
Bradley Fertilizer Co., Boston, Mass.	Farmers' new method.	Lockville.	3985
Bradley Fertilizer Co., Boston, Mass.	Fine ground bone.	Fayette. Lockville.	3920 3986
Bradley Fertilizer Co., Boston, Mass.	Muriate of potash.	Fayette.	3919
Bradley Fertilizer Co., Boston, Mass.	Patent superphosphate of lime.	Jordan.	3854
Chemical Company of Canton, Baltimore, Md.	High grade standard guano.	East Lansing. Himrods.	3815 3927
Chemical Company of Canton, Baltimore, Md.	Potato manure.	East Lansing.	3813

LECTED IN NEW YORK STATE DURING THE FALL OF 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	1.50	7	8	1	——	——
Found	1.85	7.51	11.73	1.82	0.31	3.54
Guaranteed	1.50	6	12	2	——	——
Found	1.83	4.81	13.40	2.92	0.68	1.41
Below guarantee		1.19				
Guaranteed	5	3	5	4	——	——
Found	4.85	5.68	8.21	6.78	3.81	3.59
Guaranteed	1	9	——	2.50	——	——
Found	1.14	10.32	12.10	2.62	0.32	6.54
Guaranteed	——	11	——	2.43	——	——
Found		10.75	11.64	2.49		6.13
Below guarantee		0.25				
Guaranteed	0.82	8	10	2.16	——	——
Found	1.23	9.69	12.34	2.33	0.40	3.99
Guaranteed	2.50	——	21	——	——	——
Found	3.15		23.81		0.61	
Guaranteed	——	——	——	50	——	——
Found				49.36		
Below guarantee				0.64		
Guaranteed	2.05	8	10	1.50	——	——
Found	1.87	8.79	10.78	1.63	0.86	4.45
Guaranteed	2.05	9	——	2.50	——	——
Found	2.21	8.79	10.93	2.49	0.92	6.48
Below guarantee		0.21				
Guaranteed	0.82	8	10	4	——	——
Found	0.88	7.57	9.39	5.43	0.01	1.32
Below guarantee		0.43				

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Chemical Company of Canton, Baltimore, Md.	Special wheat, corn and grass mixture.	East Lansing.	3814
Clark's Cove Fertilizer Co., New York City.	Fayette special No. 2.	MacDougall.	3916
Clark's Cove Fertilizer Co., New York City.	Good acre potato, hop and tobacco grower.	Wallington.	3979
Clark's Cove Fertilizer Co., New York City.	Seneca Co. special.	MacDougall.	3913
Clark's Cove Fertilizer Co., New York City.	Triumph bone and potash.	East Lansing.	3816
Clark's Cove Fertilizer Co., New York City.	Unicorn ammoniated superphosphate.	Wallington.	3980
Cleveland Dryer Co., Cleveland, Ohio.	Forest city ammoniated superphosphate.	Cato. Bergen.	3963 4044
E. Frank Coe Co., New York City.	Alkaline bone.	Aurora.	3810
E. Frank Coe Co., New York City.	Ammoniated bone special superphosphate.	Aurora.	3807
E. Frank Coe Co., New York City.	Ammoniated dissolved bone.	Canandaigua.	3948
E. Frank Coe Co., New York City.	Original ammoniated dissolved bone phosphate.	Batavia.	4034

LECTED IN NEW YORK STATE DURING THE FALL OF 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	0.82	9	11	2	——	——
Found	1.32	10.09	15.89	1.46	0.19	4.97
Below guarantee				0.54		
Guaranteed	——	12	——	5	——	——
Found		12.72	15.66	4.92		7.02
Guaranteed	2.05	8	9	3	——	——
Found	2.14	9.13	13.66	3.24	0.43	3.02
Guaranteed	0.82	10	——	4	——	——
Found	0.97	10.78	13.42	3.40*	0.50	4.78
Below guarantee				0.60		
Guaranteed	——	10	12	1	——	——
Found		9.81	12.16	2		2.09
Guaranteed	1.85	8.50	10	2.25	——	——
Found	1.94	9.41	13.02	1.81*	0.59	4.97
Below guarantee				0.44		
Guaranteed	1.65	7	8	1	——	——
Found	1.86	8.25	10.67	1.37	0.68	6.51
Guaranteed	1	9	11	1.85	——	——
Found	1.43	11.06	13.41	2.03*	0.69	8.21
Guaranteed	1.20	8	10	3	——	——
Found	1.41	9.51	12.28	3.28*	0.66	6.98
Guaranteed	1.25	10	——	2.25	——	——
Found	1.54	9.53	12.45	2.75*	0.91	6.55
Below guarantee		0.47				
Guaranteed	1.25	10	——	2.25	——	——
Found	1.35	9.93	12.69	3.28*	0.72	6.88

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Acid phosphate.	Morganville.	4038
Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Allis' barley special.	Clifton Springs.	3868
Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Allis' wheat special.	Clifton Springs.	3867
Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Blood and animal matter.	Gasport.	4055
Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Complete wheat fertilizer.	Memphis.	3858
Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Dissolved bone phosphate.	Auburn.	3842
Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Dissolved bone and potash special.	Auburn.	3840
Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Dissolved rock.	Penn Yan.	3934
Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Eshelmann's special wheat.	Clarence Center.	4050
Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Grain and grass grower.	Auburn.	3843
Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Grain and grass grower.	Auburn.	3844

lected in New York State During the Fall of 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	———	13	14	———	———	———
Found		12.61	14.26			8.35
Below guarantee		0.39				
Guaranteed	0.82	8	———	5	———	———
Found	1.15	9.35	9.86	5.36	0.04	5.24
Guaranteed	2	10	———	2	———	———
Found	1.92	10.75	13.16	1.64	0.39	7.65
Below guarantee				0.36		
Guaranteed	8.20	———	9	———	———	———
Found	7.18	4.21	10.79		0.20	0.34
Below guarantee	1.02					
Guaranteed	1.64	10	11	4	———	———
Found	1.32	12.34	14.87	3.28	0.14	8.91
Below guarantee	0.32			0.72		
Guaranteed	———	14	15	———	———	———
Found		15.23	16.55			10.75
Guaranteed	———	10	———	2	———	———
Found		8.98	10.04	2.45		3.95
Below guarantee		1.02				
Guaranteed	———	14	———	———	———	———
Found		14.11	15.38			10.23
Guaranteed	1.23	8	———	3	———	———
Found	1.53	9.14	10.29	3.19	0.15	5.86
Guaranteed	0.82	7	8	1.08	———	———
Found	0.90	7.02	8.12	1.09	0.05	3.02
Guaranteed	2	10	13	1.60	———	———
Found	1.78	10.83	13.17	1.83	0.66	6.97
Below guarantee	0.22					

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Ground bone meal.	Auburn.	3839
Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Hanlon Bros. special fertilizer.	Medina.	4056
Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	High-grade ammoniated wheat special.	MacDougall.	3918
Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Landon's dissolved bone with potash.	Poplar Ridge.	3804
Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Phosphoric acid and potash.	Auburn.	3841
Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Potash salts.	Morganville.	4039
Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Pure ground blood.	Gasport.	4054
Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Special high-grade ammoniated phosphate.	Poplar Ridge.	3803
Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Special high-grade wheat fertilizer.	Clyde.	3990
Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Special wheat.	East Bloomfield.	3951
Crocker Fertilizer & Chemical Co.. Buffalo, N. Y.	Special wheat grower.	Weedsport.	3960

LECTED IN NEW YORK STATE DURING THE FALL OF 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	2	———	25	———	———	———
Found	1.84		30.09		0.21	
Guaranteed	0.82	10	———	8.10	———	———
Found	0.96	10.49	12.51	7.47	0.64	7.05
Below guarantee				0.63		
Guaranteed	0.82	10	———	4	———	———
Found	1.06	10.71	11.64	4.19	0.39	7.65
Guaranteed	———	10	———	2	———	———
Found		9.77	10.83	1.46		5.41
Below guarantee		0.23		0.54		
Guaranteed	———	10	11	5.40	———	———
Found		12.17	13.29	4.63		7.81
Below guarantee				0.77		
Guaranteed	———	———	———	50	———	———
Found				50.84		
Guaranteed	12.35	———	———	———	———	———
Found	13.49					
Guaranteed	1.64	8	9	3	———	———
Found	1.98	8.14	10.57	4.07	0.15	5.48
Guaranteed	1.65	10	———	5	———	———
Found	2.58	9.91	10.93	3.30	1.33	7.66
Below guarantee				1.70		
Guaranteed	1.64	8	———	3	———	———
Found	2.09	8.55	9.68	2.84	0.05	5.65
Guaranteed	2	8	9	3.25	———	———
Found	2.44	9.76	12.04	5.86	0.14	6.30

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Crocker Fertilizer Co., Buffalo, N. Y.	Tompkins County guano special.	East Lansing.	3819
Crocker Fertilizer Co., Buffalo, N. Y.	Toynbee Bros. special wheat and rye.	Bowmansville.	4052
Crocker Fertilizer Co., Buffalo, N. Y.	Vegetable bone superphosphate.	Gasport.	4053
Crocker Fertilizer Co., Buffalo, N. Y.	Webster ammoniated superphosphate.	Webster.	4013
Crocker Fertilizer Co., Buffalo, N. Y.	Webster high-grade superphosphate.	Webster.	4014
Crocker Fertilizer Co., Buffalo, N. Y.	Yates special fertilizer.	Farmer.	3883
E. A. Cross, Hilton, N. Y.	King superphosphate.	Hilton.	4062
E. A. Cross, Hilton, N. Y.	Queen superphosphate.	Hilton.	4061
E. A. Cross, Hilton, N. Y.	Parma superphosphate.	Hilton.	4060
Cumberland Bone Phosphate Co., Portland, Me.	Bone and potash.	Ithaca.	3820
Cumberland Bone Phosphate Co., Portland, Me.	Concentrated phosphate.	North Rose.	3977

LECTED IN NEW YORK STATE DURING THE FALL OF 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	1.03	9	10	2.50	——	——
Found	1.26	9.09	12.94	2.17	0.27	6.47
Below guarantee				0.33		
Guaranteed	1.23	10	——	3	——	——
Found	0.97	9.70	10.72	4.47	0.34	6.04
Below guarantee	0.26	0.30				
Guaranteed	5	6	——	5.94	——	——
Found	4.89	6.90	7.52	6.87	1.07	5.63
Guaranteed	1.23	8	——	4	——	——
Found	1.30	9.98	11.34	3.37	0.08	7.46
Below guarantee				0.63		
Guaranteed	1.85	8	——	4	——	——
Found	2.16	9.23	11.36	4.08	0.30	6.53
Guaranteed	1.03	9	——	2.50	——	——
Found	1.20	9.62	12.32	2.76	0.38	6.16
Guaranteed	2.35	8	10.25	3.40	——	——
Found	2.45	7.37	10.24	3.80*	1.45	3.78
Below guarantee		0.63				
Guaranteed	2	8	10	3	——	——
Found	2.06	7.27	10.27	3.81	1.20	3.21
Below guarantee		0.73				
Guaranteed	1.65	8	9.50	3.20	——	——
Found	1.69	8.44	10.37	3.42	0.99	4.22
Guaranteed	——	8	10	2.50	——	——
Found		9	10.70	2.48		4.26
Guaranteed	3.20	8	10	7	——	——
Found	3.28	7.83	10.25	6.51	1.50	3.32
Below guarantee				0.49		

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Cumberland Bone Phosphate Co., Portland, Me.	Superphosphate.	North Rose.	3976
L. B. Darling Fertilizer Co., Pawtucket, R. I.	Animal fertilizer.	Moravia.	3832
Detrick Fertilizer Co., Baltimore, Md.	Ammoniated bone phosphate.	Rochester.	4010
Detrick Fertilizer Co., Baltimore, Md.	Imperial compound.	Rochester.	4009
Detrick Fertilizer Co., Baltimore, Md.	Potato fertilizer.	Rochester.	4011
Detrick Fertilizer Co., Baltimore, Md.	Soluble bone phosphate and potash.	Rochester.	4012
Louis F. Detrick, Baltimore, Md.	XXTRA acid phosphate.	Poplar Ridge.	3806
W. S. Farmer & Co., Baltimore, Md.	Clyde brand.	East Lansing.	3812
W. S. Farmer & Co., Baltimore, Md.	Harvest queen phosphate.	East Lansing.	3811
Carlton G. Fisher, Darien Center, N. Y.	Reliance brand.	Darien Center.	4033
Geneva Coal Co., Geneva, N. Y.	Dissolved bone and potash.	Geneva.	3911

LECTED IN NEW YORK STATE DURING THE FALL OF 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	2.05	8	10	2	——	——
Found	2.21	8.93	11.57	2	0.48	4.87
Guaranteed	3.30	6	10	4	——	——
Found	3.43	7.22	13.56	4.44	1.23	2.83
Guaranteed	1.23	9	11	1	——	——
Found	1.35	8.94	11.58	1.13	0.33	4.98
Guaranteed	0.82	9	10.50	1	——	——
Found	0.90	8.92	11.25	1.20	0.23	5.21
Guaranteed	2.06	8	9	4	——	——
Found	2.02	8.62	10.62	4.34	0.72	4.84
Guaranteed	——	10	11	2	——	——
Found		9.82	15.88	2.42		4.08
Guaranteed	——	14	14.75	——	——	——
Found		15.58	16.50			12
Guaranteed	0.82	9	10	2.50	——	——
Found	0.87	9.61	10.24	1.83	0.23	6.81
Below guarantee				0.67		
Guaranteed	1.23	10	——	2.50	——	——
Found	1.19	9.64	10.61	2.37	0.43	7.24
Below guarantee		0.36				
Guaranteed	1.65	9	11	2	——	——
Found	1.73	8.95	11.23	2.35	0.58	5.58
Guaranteed	——	13	——	3	——	——
Found		15.06	15.13	3.15		11.76

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Geneva Coal Co., Geneva, N. Y.	Dissolved bone phosphate.	Geneva.	3873
Geneva Coal Co., Geneva, N. Y.	Early trucker for onions.	Geneva.	3875
Geneva Coal Co., Geneva, N. Y.	Harvest king.	Geneva.	3910
Geneva Coal Co., Geneva, N. Y.	Mortgage raiser.	Geneva.	3872
Geneva Coal Co., Geneva, N. Y.	New York standard wheat grower.	Geneva.	3869
Geneva Coal Co., Geneva, N. Y.	Oats and barley special.	Geneva.	3870
Geneva Coal Co., Geneva, N. Y.	Reclaimer animal bone fertilizer.	Geneva.	3871
Geneva Coal Co., Geneva, N. Y.	Standard corn and potato manure.	Geneva.	3874
Great Eastern Fertilizer Co., New York City.	General wheat special.	Union Springs. Oakfield.	3793 4035
Great Eastern Fertilizer Co., New York City.	Northern corn special.	Jordan.	3853
Ira C. Hall, Farmer, N. Y.	Black diamond guano.	Farmer,	3880

lected in New York State During the Fall of 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	———	14	15	———	———	———
Found		15.35	16.02			11.06
Guaranteed	3.30	7	———	8	———	———
Found	3.02	6.81	8.96	8.88	1.65	3.48
Below guarantee	0.28					
Guaranteed	0.82	9	———	2	———	———
Found	1.02	9.57	10.89	2.29	0.56	5.24
Guaranteed	0.82	10	———	8	———	———
Found	0.84	10.46	11.25	7.92	0.53	7.62
Guaranteed	1.65	9	———	2	———	———
Found	1.70	9.72	11.02	2.33	0.68	6.88
Guaranteed.	0.82	8	———	4	———	———
Found	0.84	9.36	10.38	4.29	0.47	6.88
Guaranteed	1.85	9	———	4	———	———
Found	1.99	10.15	14.16	4.18	0.76	7.25
Guaranteed	2.47	7	———	8	———	———
Found	2.45	7.30	9.27	7.80	1.12	5.03
Guaranteed	1.60	8	———	2	———	———
Found	1.90	9.69	11.88	2.23*	0.57	5.96
Guaranteed	2.47	8	9	2	———	———
Found	2.30	9.57	13.31	2.29	0.28	7.21
Guaranteed	1.85	9	———	4	———	———
Found	1.87	9.94	11.21	4.39	0.87	7.54

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Ira C. Hall, Farmer, N. Y.	Home rule.	Farmer.	3882
Ira C. Hall, Farmer, N. Y.	Seneca chief.	Farmer.	3881
Ira C. Hall, Farmer, N. Y.	Special wheat grower.	Farmer.	3879
J. S. Hewitt & Sons, Locke, N. Y.	Cayuga Co. pride fertilizer.	Locke.	3828
J. S. Hewitt & Sons, Locke, N. Y.	Special grain and grass fertilizer.	Locke.	3827
C. C. Hicks, Penn Yan, N. Y.	Cook's special.	Penn Yan.	3929
C. C. Hicks, Penn Yan, N. Y.	Guaranteed animal bone fertilizer.	Penn Yan.	3931
C. C. Hicks, Penn Yan, N. Y.	Ontario wheat special.	Penn Yan.	3943
C. C. Hicks, Penn Yan, N. Y.	Prolific fertilizer.	Penn Yan.	3932
C. C. Hicks, Penn Yan, N. Y.	Soluble bone.	Penn Yan.	3933
C. C. Hicks, Penn Yan, N. Y.	Standard guano.	Penn Yan.	3930

LECTED IN NEW YORK STATE DURING THE FALL OF 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water soluble potash in 100 pounds of fertilizer.	Pounds of water soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	0.83	9	———	2.50	———	———
Found	0.96	9.46	10.72	2.63	0.46	6.51
Guaranteed	1.85	9	———	4	———	———
Found	2.09	9.81	13.44	4.33	0.78	7.41
Guaranteed	1.65	9	———	2	———	———
Found	1.68	10.17	11.06	2.27	0.69	7.04
Guaranteed	1.85	8	9	4	———	———
Found	1.88	9.68	12.21	4.16	0.11	6.81
Guaranteed	0.82	8	9	4	———	———
Found	1.02	9.10	10.46	4.14	0.26	6.13
Guaranteed	0.82	8	———	4	———	———
Found	0.80	9.39	10.41	4.27	0.45	6.73
Guaranteed	1.85	9	———	4	———	———
Found	2.06	9.99	14.03	4.27	0.83	7.52
Guaranteed	1.65	10	———	5	———	———
Found	1.82	11.02	11.96	5	0.90	8.68
Guaranteed	0.82	10	———	8	———	———
Found	0.83	10.63	11.53	8.11	0.54	8.12
Guaranteed	———	14	———	———	———	———
Found		13.72	16.52			9.78
Below guarantee		0.28				
Guaranteed	1.23	10	———	3	———	———
Found	1.49	10.29	11.20	3.09	0.91	8.42

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Lazaretto Guano Co., Baltimore, Md.	Alkaline dissolved bone phosphate.	Bergen.	4045
Lazaretto Guano Co., Baltimore, Md.	Dissolved bone and potash.	Bergen.	4046
Lazaretto Guano Co., Baltimore, Md.	New York Standard No. 2.	Bowmansville.	4051
Liebig Manufacturing Co., Carteret, N. J.	Dissolved bone.	Moravia.	3830
Liebig Manufacturing Co., Carteret, N. J.	High-grade bone and potash.	Union Springs.	3796
Liebig Manufacturing Co., Carteret, N. J.	Standard phosphate.	Union Springs.	3795
Liebig Manufacturing Co., Carteret, N. J.	T. & F. bone and potash.	Moravia.	3829
Lister Agr'l Chemical Works, Newark, N. J.	Animal bone and potash No. 2.	Pittsford.	4001
Lister Agr'l Chemical Works, Newark, N. J.	Pontius' ammoniated dissolved bone and potash.	Kendaia.	3892
Locke Fertilizer Co., Locke, N. Y.	Farmers' favorite.	Locke.	3824
Locke Fertilizer Co., Locke, N. Y.	Full value animal bone.	Locke.	3825

LECTED IN NEW YORK STATE DURING THE FALL OF 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	———	13	———	3	———	———
Found		15.33	15.53	3.34		12.19
Guaranteed	———	10	———	2	———	———
Found		11.64	12.54	2.24		8.01
Guaranteed	1.23	10	———	3	———	———
Found	1.31	10.35	11.17	3.36	0.71	8.44
Guaranteed	———	14	———	———	———	———
Found		16.24	17.27			12.46
Guaranteed	———	10	———	5	———	———
Found		13.12	15.41	4.19		2.84
Below guarantee				0.81		
Guaranteed	1.25	10	———	2.50	———	———
Found	1.38	12.78	14.08	2.32	0.78	1.03
Guaranteed	———	13	———	5	———	———
Found		13.46	14.94	6.19		10.04
Guaranteed	———	9	10	3	———	———
Found		9.70	10.42	3.91		5.85
Guaranteed	0.82	8	———	4	———	———
Found	1	8.76	10.40	3.87*	0.60	6.62
Guaranteed	1.23	10	———	3	———	———
Found	1.37	10.26	11.21	2.94	0.77	8.63
Guaranteed	1.85	9	———	4	———	———
Found	2.10	11.03	14.77	4.18	0.76	7.56

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Locke Fertilizer Co., Locke, N. Y.	Good enough fertilizer.	Locke.	3823
Locke Fertilizer Co., Locke, N. Y.	Imperial superphosphate.	Locke.	3826
Lowell Fertilizer Co., Lowell, Mass.	Animal brand.	Gorham.	3907
Lowell Fertilizer Co., Lowell, Mass.	Bone fertilizer for corn and grain.	Gorham.	3908
Lowell Fertilizer Co., Lowell, Mass.	Empire brand.	Moravia. Gorham.	3831 3906
Lowell Fertilizer Co., Lowell, Mass.	Fruit and vine.	Manchester.	3922
Frederick Ludlam, New York City.	Acid phosphate.	Skaneateles.	3851
Frederick Ludlam, New York City.	Cereal brand.	Moravia.	3837
Frederick Ludlam, New York City.	Dragon's tooth brand.	Moravia.	3838
Frederick Ludlam, New York City.	P. G. brand.	Moravia.	3836
Maryland Fertilizing and Manufacturing Co., Baltimore, Md.	A. E. fertilizer.	East Lansing. Fairport.	3817 4021

lected in New York State During the Fall of 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	1.85	9	——	4	——	——
Found	1.87	9.33	10.79	4.27	0.88	7.61
Guaranteed	1.85	9	——	2	——	——
Found	1.69	10.32	11.46	2.27	0.77	7.34
Guaranteed	2.46	9	——	4	——	——
Found	2.49	9.34	10.79	3.90*	1.28	6.39
Guaranteed	1.65	8	——	3	——	——
Found	1.69	7.99	8.95	4.22	0.83	3.31
Guaranteed	1.23	7	——	2	——	——
Found	1.36	7.71	9.41	2.21	0.78	4.96
Guaranteed	2.47	7	——	6	——	——
Found	2.62	7.25	8.47	6.54*	0.84	5.40
Guaranteed	——	14	15	——	——	——
Found		15.32	17.50			9.38
Guaranteed	0.75	8	10	1	——	——
Found	0.90	9.25	14.36	1.16	0.23	3.62
Guaranteed	3	7	——	7	——	——
Found	3.35	10.75	12.92	6.79	1.55	8.71
Below guarantee				0.21		
Guaranteed	——	10	11	6	——	——
Found		11.29	13.54	4.96		7.25
Below guarantee				1.04		
Guaranteed	——	9	——	2.50	——	——
Found		11.22	12.71	2.68		7.38

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Maryland Fertilizing and Manufacturing Co., Baltimore, Md.	Alkaline bone.	Fairport.	4022
Maryland Fertilizing and Manufacturing Co., Baltimore, Md.	Bone superphosphate	Fairport.	4020
Maryland Fertilizing and Manufacturing Co., Baltimore, Md.	Linden superphosphate.	Elbridge.	3852
Maryland Fertilizing and Manufacturing Co., Baltimore, Md.	Sangston's cereal plant food.	Fairport.	4019
Maryland Fertilizing and Manufacturing Co., Baltimore, Md.	Tornado.	Fairport.	4018
Michigan Carbon Works, Detroit, Mich.	Banner dissolved bone.	MacDougall.	3917
Michigan Carbon Works, Detroit, Mich.	Homestead fertilizer.	Cato.	3961
Miller Fertilizer Co., Baltimore, Md.	A. Baldridge's Seneca queen.	MacDougall.	3912
Miller Fertilizer Co., Baltimore, Md.	Ground bone.	Moravia.	3834
Miller Fertilizer Co., Baltimore, Md.	Harvest queen phosphate.	Moravia.	3835
Miller Fertilizer Co., Baltimore, Md.	S. C. bone.	Moravia.	3833

LECTED IN NEW YORK STATE DURING THE FALL OF 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	—	11.75	12	3.50	—	—
Found		12.96	13.85	3.45		9.22
Guaranteed	—	10	11	2	—	—
Found		12.88	14.09	1.49		9.95
Below guarantee				0.51		
Guaranteed	—	11	12	1.50	—	—
Found		10.80	13.08	2.26		7.17
Guaranteed	1.03	10	11	2.25	—	—
Found	1.11	10.55	14.22	2.14	0.68	6.40
Guaranteed	0.41	11	12	3.25	—	—
Found	0.58	11.31	13.35	3.84	0.12	8.40
Guaranteed	—	30	34	—	—	—
Found		27	35.42			0.48
Below guarantee		3				
Guaranteed	1.85	8	—	1.50	—	—
Found	2.26	10.63	11.38	2.33	0.95	8.20
Guaranteed	—	14	—	—	—	—
Found		15.22	16.47			11.31
Guaranteed	2.47	—	15	—	—	—
Found	2.86		18.47		0.77	3.68
Guaranteed	1	10	11.50	2.25	—	—
Found	1.08	10.52	11.80	2.50	0.23	7.21
Guaranteed	—	14	—	—	—	—
Found		15.26	16.55			11.13

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Milsom Rendering & Fertilizer Co., Buffalo, N. Y.	Acid phosphate.	Gorham.	3866
Milsom Rendering & Fertilizer Co., Buffalo, N. Y.	Ammoniated bone and potash.	Canandaigua.	3947
Milsom Rendering & Fertilizer Co., Buffalo, N. Y.	Buckwheat special fertilizer.	Wolcott.	3975
Milsom Rendering & Fertilizer Co., Buffalo, N. Y.	Cyclone pure bone meal.	Auburn.	3845
Milsom Rendering & Fertilizer Co., Buffalo, N. Y.	Grain special No. 1.	Canandaigua.	3945
Milsom Rendering & Fertilizer Co., Buffalo, N. Y.	Grain special No. 2.	Canandaigua.	3946
Milsom Rendering & Fertilizer Co., Buffalo, N. Y.	Noonan's dissolved bone and potash.	East Avon.	4031
Milsom Rendering & Fertilizer Co., Buffalo, N. Y.	Noonan's special.	East Avon.	4032
Milsom Rendering & Fertilizer Co., Buffalo, N. Y.	Perry's special dissolved bone with potash.	West Henrietta.	3955
Milsom Rendering & Fertilizer Co., Buffalo, N. Y.	Weed's wheat special.	Clyde.	3997
Geo. L. Munroe. Oswego, N. Y.	Pure Canada hard wood ashes.	Moscow.	4025

lected in New York State During the Fall of 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	——	13	——	——	——	——
Found		13.63	14.30			8.48
Guaranteed	2.46	8	11	7	——	——
Found	1.90	7.87	9.83	6.42*	0.67	6.06
Below guarantee	0.56			0.58		
Guaranteed	0.82	7	9	1.08	——	——
Found	0.97	8.38	10.35	1.16	0.60	6.31
Guaranteed	2.46	——	24	——	——	——
Found	2.65		24.14		0.40	
Guaranteed	1	10	11	6	——	——
Found	0.91	9.71	11.27	4.93	0.23	7.40
Below guarantee		0.29		1.07		
Guaranteed	1.25	10	11	4	——	——
Found	1.30	9.22	11.05	4.61	0.80	7.13
Below guarantee		0.78				
Guaranteed	——	10	——	8	——	——
Found		10.05	10.38	6.77		5.65
Below guarantee				1.23		
Guaranteed	——	12	——	4	——	——
Found		10.78	11.18	3.31		6.07
Below guarantee		1.22		0.69		
Guaranteed	——	12	14	3	——	——
Found		12.91	13.25	2.95		8.22
Guaranteed	1.64	4	5	4	——	——
Found	1.75	3.81	5.67	3.97	0.32	2.35
Guaranteed	——	——	1	4.50	——	——
Found			1.46	4.72		

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Niagara Fertilizer Co., Buffalo, N. Y.	Brophel's special standard wheat fertilizer.	Moscow.	4024
Niagara Fertilizer Co., Buffalo, N. Y.	Brophel's standard brand wheat fertilizer No. 2.	Moscow.	4023
Niagara Fertilizer Works, Buffalo, N. Y.	Special wheat fertilizer No. 1.	Shortsville.	3876
Niagara Fertilizer Works, Buffalo, N. Y.	Special wheat fertilizer No. 1.	Shortsville.	3877
Niagara Fertilizer Works, Buffalo, N. Y.	Wheat special.	Waterloo	3861
Oakfield Fertilizer Co., Buffalo, N. Y.	Domestic.	Locke.	3822
Oakfield Fertilizer Co., Buffalo, N. Y.	Genesee Co. wheat grower.	Oakfield.	4037
Oakfield Fertilizer Co., Buffalo, N. Y.	Special corn and wheat manure.	Oakfield.	4036
Oakfield Fertilizer Co., Buffalo, N. Y.	Special hop "A."	Sodus.	3982
Oakfield Fertilizer Co., Buffalo, N. Y.	Standard fertilizer.	Sodus Center.	3981
Pacific Guano Co., New York City.	Dissolved bone phosphate of lime.	Wolcott.	3974

LECTED IN NEW YORK STATE DURING THE FALL OF 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	0.82	8	——	2	——	——
Found	0.91	8.59	9.86	2.64	0.37	4.98
Guaranteed	2.10	8	——	2	——	——
Found	2.22	8.19	9.55	2.22	0.55	4.88
Guaranteed	1.64	8	——	3.25	——	——
Found	1.70	8.29	10.47	3.31	0.19	5.39
Guaranteed	——	12	——	2.16	——	——
Found		12.03	13.30	2.51		9.30
Guaranteed	0.82	10	——	3	——	——
Found	1.14	10.37	13.02	3.93	0.20	7.22
Guaranteed	1.65	8	9	1.08	——	——
Found	2.10	9.51	11.05	1.40	0.38	5.57
Guaranteed	1	10	——	5	——	——
Found	1.02	11.36	12.09	5.07	0.05	7.31
Guaranteed	3.70	8	——	6	——	——
Found	3.78	7.83	9.45	6.63	0.90	3.26
Guaranteed	0.82	6	8	6.50	——	——
Found	0.76	6.55	7.92	6.16	0.06	1.51
Below guarantee				0.34		
Guaranteed	2.47	10	11	1.62	——	——
Found	2.97	11.30	12.38	2.35	2.15	5.20
Guaranteed	——	12	13	——	——	——
Found		13.74	15.76			9.86

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Pacific Guano Co., New York City.	Potato, tobacco and hop fertilizer.	Wolcott.	3973
Pacific Guano Co., New York City.	Special for potatoes and tobacco.	Pembroke.	4049
Packers' Union Fertilizer Co., New York City.	High-grade universal fertilizer.	Union Springs.	3792
Packers' Union Fertilizer Co., New York City.	Oats and clover fertilizer.	Baldwinsville.	3860
Packers' Union Fertilizer Co., New York City.	Old Abe universal fertilizer.	Baldwinsville.	3859
Patapsco Guano Co., Baltimore, Md.	Alkaline soluble bone.	Mandana.	3850
Patapsco Guano Co., Baltimore, Md.	Animal bone and potash.	Ovid.	3888
Patapsco Guano Co., Baltimore, Md.	Bone and potash compound.	Weedsport.	3958
Patapsco Guano Co., Baltimore, Md.	Grain and grass.	Ovid.	3889
Patapsco Guano Co., Baltimore, Md.	High-grade ammoniated bone and potash compound.	Weedsport.	3957
Patapsco Guano Co., Baltimore, Md.	Soluble bone.	Ovid.	3890

LECTED IN NEW YORK STATE DURING THE FALL OF 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	2.05	8	9	3	——	——
Found	2.29	9.17	13.11	3.34	0.48	3.47
Guaranteed	2.06	8	9	3	——	——
Found	2.22	10.11	12.34	3.13	0.68	5.52
Guaranteed	0.82	8	9	5	——	——
Found	1.22	8.26	9.95	4.72	0.06	5.46
Below guarantee				0.28		
Guaranteed	——	11	——	2	——	——
Found		11	13.90	1.96		4.08
Guaranteed	0.82	8	9	5	——	——
Found	1.06	8.46	10 23	4.84	0.20	6.02
Guaranteed	——	12	——	3	——	——
Found		14.37	14.87	2.81		11.16
Guaranteed	1.85	9	——	4	——	——
Found	2.02	10.40	14.67	3.86	0.72	7.48
Guaranteed	——	10	11	3	——	——
Found		10.87	11.95	1.92		4.17
Guaranteed	1.23	10	——	3	——	——
Found	1.40	10.60	11.30	3.20	0.78	8.19
Guaranteed	0.82	7	9	8	——	——
Found	0.95	8.52	9.77	8.60	0.43	5.12
Guaranteed	——	14	——	——	——	——
Found		15.74	16.44			11.31

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Moro Phillips Chemical Co., Philadelphia, Pa.	C. & G. complete fertilizer.	Sherwood.	3800
Moro Phillips Chemical Co., Philadelphia, Pa.	Half and half.	Sherwood. Kendaia.	3798 3894
Moro Phillips Chemical Co., Philadelphia, Pa.	Soluble bone phosphate.	Sherwood. Milo Center.	3799 3941
Moro Phillips Chemical Co., Philadelphia, Pa.	Special fertilzer.	Sherwood. Milo Center.	3802 3742
Moro Phillips Chemical Co., Philadelphia, Pa.	Standard guano.	Sherwood. Milo Center.	3801 3940
Moro Phillips Chemical Co., Philadelphia, Pa.	Standard phosphate.	Kendaia.	3893
Moro Phillips Chemical Co., Philadelphia, Pa.	Tompkins Co. guano special.	East Lansing.	3818
Quinnipiac Co., New York City.	Ammoniated bone phosphate.	Lima.	3905
Quinnipiac Co., New York City.	Ammoniated wheat manure.	East Bloomfield.	3950
Quinnipiac Co., New York City.	Bachman's special complete manure.	MacDougall.	3928
Quinnipiac Co., New York City.	Fish, bone and potash.	Fairhaven.	3964

lected in New York State During the Fall of 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	1	8	9	1.50	——	——
Found	0.90	7.99	9.62	1.55	0.43	5.55
Guaranteed	——	10	11	5.50	——	——
Found		10.37	11.63	5.96		5.17
Guaranteed	——	14	15	——	——	——
Found		14.02	15.23			9.56
Guaranteed	1.85	9	10	4.75	——	——
Found	1.90	9.11	11.87	4.88	0.26	5.93
Guaranteed	0.82	10	12	4	——	——
Found	0.90	10.17	12.73	2.98	0.29	5.75
Below guarantee				1.02		
Guaranteed	1	9	11	2.50	——	——
Found	1.28	9.28	11.53	6.09	0.66	6.14
Guaranteed	1	9	11	2.50	——	——
Found	1.35	8.76	10.07	2.52	0.58	5.55
Below guarantee		0.24				
Guaranteed	0.82	8	——	4	——	——
Found	1.07	8.46	12.26	3.82	0.52	2.42
Guaranteed	1.64	10	——	5	——	——
Found	2.18	10.07	14.08	4.67	0.54	3.20
Below guarantee				0.33		
Guaranteed	0.82	10	——	4	——	——
Found	1.27	9.89	12.70	4.06*	0.33	4.58
Guaranteed	1.65	9	10	1	——	——
Found	2.06	9.06	13.44	1.16*	0.67	4.08

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Quinnipiac Co., New York City.	Grain and seeding phosphate.	Rochester.	4005
Quinnipiac Co., New York City.	Grain phosphate.	Lima.	3904
Quinnipiac Co., New York City.	Potash and bone.	Rochester.	4006
Quinnipiac Co., New York City.	Soluble dissolved bone.	Springport.	3794
Quinnipiac Co., New York City.	Soluble dissolved bone.	Dundee.	3923
Quinnipiac Co., New York City.	Special wheat fertilizer.	Mandana.	3849
Rasin Fertilizer Co., Baltimore, Md.	Rasin acid phosphate.	Penn Yan.	3937
Read Fertilizer Co., New York City.	Acid phosphate.	Himrods.	3926
Read Fertilizer Co., New York City.	Jones' ammoniated dissolved bone.	Himrods.	3924
Read Fertilizer Co., New York City.	Jones' special alkaline bone.	Himrods.	3925
Read Fertilizer Co., New York City.	Prime wheat fertilizer.	Poplar Ridge.	3805

lected in New York State During the Fall of 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	0.82	8	9	5	———	———
Found	1.14	8.46	10.89	5.24	0.36	5.12
Guaranteed	1.64	9	———	4	———	———
Found	2.02	9.45	12	4.45	1.05	6.34
Guaranteed	———	10	13.25	6	———	———
Found		10.06	13.25	5.57		3.27
Below guarantee				0.43		
Guaranteed	———	14	15	———	———	———
Found		15.44	16.99			12.67
Guaranteed	———	13	14	———	———	———
Found		14.76	16.43			11.66
Guaranteed	1.65	10	———	4	———	———
Found	1.97	11.22	15.10	4.11	0.06	5.05
Guaranteed	———	14	———	———	———	———
Found		14.51	15.33			11.01
Guaranteed	———	13	———	———	———	———
Found.		15.06	15.71			10.29
Guaranteed.	0.83	10	———	8	———	———
Found	0.72	9.75	12.50	6.66	0.12	5.54
Below guarantee		0.25		1.34		
Guaranteed	———	13	———	3	———	———
Found		13.88	16.64	2.10		4.17
Below guarantee				0.90		
Guaranteed	1.65	8	9	4	———	———
Found	1.66	8.03	9.17	4.06	0.47	6.28

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Read Fertilizer Co., New York City.	Standard superphosphate.	Skaneateles.	3846
John. S. Reese & Co., Baltimore, Md.	Bone phosphate mixture.	Penn Yan.	3936
John. S. Reese & Co., Baltimore, Md.	Elm phosphate.	Penn Yan.	3935
John. S. Reese & Co., Baltimore, Md.	Half and half.	Fayette.	3921
John. S. Reese & Co., Baltimore, Md.	Special alkaline bone.	Albion.	4057
Standard Fertilizer Co., Boston. Mass.	Bone and potash.	Wolcott.	3968
I. P. Thomas & Son Co., Philadelphia. Pa.	Farmers' choice bone phosphate.	Sherwood. Churchville.	3809 4043
I. P. Thomas & Son Co., Philadelphia, Pa.	Improved superphosphate.	Sherwood.	3808
I. P. Thomas & Son Co., Philadelphia. Pa.	Normal bone phosphate.	Levanna.	3797
I. P. Thomas & Son Co., Philadelphia, Pa.	S. C. phosphate.	Penn Yan.	3938
Henry F. Tucker Co., Boston, Mass.	Imperial bone superphosphate.	Wolcott. Rochester.	3965 4007

lected in New York State During the Fall of 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	0.88	8	9	4	——	——
Found	1.01	8.46	10.57	3.87	0.15	6.06
Guaranteed	0.82	10	——	3	——	——
Found	1.74	10.85	12.47	2.36	0.88	0.65
Below guarantee				0.64		
Guaranteed	——	14	——	——	——	——
Found		14.72	15.70			10.71
Guaranteed	0.82	8	——	1	——	——
Found	0.98	11.85	13.85	0.58	0.30	1.55
Below guarantee				0.42		
Guaranteed	——	10	12	1	——	——
Found		11.67	13.99	1.09		6.04
Guaranteed	——	8	10	2.50	——	——
Found		13.20	14.73	2.30		7.66
Guaranteed	2	9.50	11	2	——	——
Found	2.57	9.46	12.59	2.18	0.90	5.71
Guaranteed	1	10	12	1	——	——
Found	0.80	9.94	10.88	1.36	0.37	6.98
Guaranteed	1	8.50	9	1.50	——	——
Found	1.54	9.35	12.06	2.70	0.34	5.35
Guaranteed	——	14	——	——	——	——
Found		16.55	17.51			12.33
Guaranteed	1.03	8	9	2.15	——	——
Found	1.55	8.26	10.83	2.69	0.49	4.78

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Henry F. Tucker Co., Boston, Mass.	Original Bay State bone superphosphate.	Wolcott. Rochester.	3966 4008
G. O. P. Turner, Churchville, N. Y.	Dissolved bone with potash.	Churchville.	4042
G. O. P. Turner, Churchville, N. Y.	High-grade guano.	Churchville.	4040
G. O. P. Turner, Churchville, N. Y.	None such.	Churchville.	4041
Walker Fertilizer Co., Clifton Springs, N. Y.	Acid phosphate.	Clifton Springs.	3863
Walker Fertilizer Co., Clifton Springs, N. Y.	Ammoniated phosphate.	East Bloomfield. Sodus.	3954 3984
Walker Fertilizer Co., Clifton Springs, N. Y.	Cabbage special.	Clyde.	3995
Walker Fertilizer Co., Clifton Springs, N. Y.	Clifton.	Sodus.	3983
Walker Fertilizer Co., Clifton Springs, N. Y.	Hop and tobacco grower.	Jordan.	3855
Walker Fertilizer Co., Clifton Springs, N. Y.	Old Pittsburg.	East Bloomfield.	3953
Walker Fertilizer Co., Clifton Springs, N. Y.	Onion special.	Clyde.	3996

LECTED IN NEW YORK STATE DURING THE FALL OF 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	1.65	9	10	2	———	———
Found	1.65	9.53	11.77	2.34	0.59	7.33
Guaranteed	———	10	———	3	———	———
Found		13.75	14.69	3.03		9.56
Guaranteed	2.50	9	———	4.75	———	———
Found	2.01	8.38	9.35	4.36	0.67	6.39
Below guarantee	0.49	0.62		0.39		
Guaranteed	1.25	10	———	7	———	———
Found	1.35	8.14	9.78	6.28	0.75	5.94
Below guarantee		1.86		0.72		
Guaranteed	———	16	———	———	———	———
Found		17.32	18.85			13.33
Guaranteed	1.65	8	———	1	———	———
Found	2.26	7.78	9.17	1.09	0.43	5.71
Below guarantee		0.22				
Guaranteed	3.29	5	———	7	———	———
Found	3.37	4.48	7.29	6.81	0.30	2.10
Below guarantee		0.52				
Guaranteed	2.47	10	———	2.50	———	———
Found	3.07	8.33	10.64	2.80	0.30	4.05
Below guarantee		1.67				
Guaranteed	3.29	6	7	5	———	———
Found	3.40	6.24	7.01	4.97	0.27	3.90
Guaranteed	1.65	8	———	3	———	———
Found	1.82	9.43	9.78	3.23	0.04	6.02
Guaranteed	2.47	7	———	8	———	———
Found	2.41	6.88	8.19	9.02	1.10	4.14

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Walker Fertilizer Co., Clifton Springs, N. Y.	Ontario brand.	East Bloomfield. Clyde.	3952 3994
Walker Fertilizer Co., Clifton Springs, N. Y.	Potato and vegetable grower.	Jordan.	3856
Walker Fertilizer Co., Clifton Springs, N. Y.	Pure ground bone.	Clifton Springs.	3864
Walker Fertilizer Co., Clifton Springs, N. Y.	Special mixture.	Pittsford.	4002
Walker Fertilizer Co., Clifton Springs, N. Y.	Victoria bone.	Jordan.	3857
Walker Fertilizer Co., Clifton Springs, N. Y.	Wheat special No. 2.	Clifton Springs. Clyde.	3862 3993
Walker, Stratman & Co., Pittsburg, Pa.	Four fold.	Gorham.	3909
Williams & Clark Fertilizer Co., New York City.	Americus brand potato phosphate.	Locke.	3821
Williams & Clark Fertilizer Co., New York City.	Goodrich grain fertilizer.	Lima.	3903
Williams & Clark Fertilizer Co., New York City.	Special "A" brand.	Pittsford.	4003
Williams & Clark Fertilizer Co., New York City.	Special "B" brand.	Pittsford.	4004

LECTED IN NEW YORK STATE DURING THE FALL OF 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	——	10	——	4	——	——
Found		10.59	11.99	3.78		6.81
Below guarantee				0.22		
Guaranteed	2.47	6	——	7	——	——
Found	2.76	5.62	7.92	6.82	0.25	3.63
Below guarantee		0.38				
Guaranteed	3.70	——	21	——	——	——
Found	4.15		22.98		2.14	
Guaranteed	0.82	7	——	2	——	——
Found	0.96	7.54	7.85	2.62		3.95
Guaranteed	0.82	8	——	1.50	——	——
Found	0.83	8.36	8.98	1.75		4.92
Guaranteed	1.65	11	——	5	——	——
Found	1.63	11.44	12.69	5.13	0.01	6.78
Guaranteed	1	8	——	1	——	——
Found	1.43	9.53	10.90	1.31	0.21	5.52
Guaranteed	2.47	6	7	5	——	——
Found	2.49	6.19	9.80	5.06	0.74	2.05
Guaranteed	2	10	——	5	——	——
Found	2.37	10.90	13.61	4.47	1.42	5.89
Below guarantee				0.53		
Guaranteed	1.65	8	9	4	——	——
Found	2.01	8.39	9.54	4.87	1.90	6.20
Guaranteed	0.82	8	9	4	——	——
Found	1.30	6.87	8.75	4.57*	0.36	4.06
Below guarantee		1.13				

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Williams & Clark Fertilizer Co., New York City.	Standard grain.	Holley.	4058
Williams & Clark Fertilizer Co., New York City.	Standard grain and vegetable.	Holley.	4059
Wooster & Mott, Union Hill, N. Y.	Alkaline bone.	Union Hill.	4016
Wooster & Mott, Union Hill, N. Y.	Grain and grass.	Union Hill.	4017
Wooster & Mott, Union Hill, N. Y.	Storm king.	Union Hill.	4015
York Chemical Works, York, Pa.	Ammoniated bone and potash.	Romulus.	3896
York Chemical Works, York, Pa.	New York phosphate.	Romulus.	3895
Zell Guano Co., Baltimore, Md.	Dissolved S. C. phosphate.	Mandana.	3848
Zell Guano Co., Baltimore, Md.	Economizer.	Kendaia. Wolcott.	3891 3972
Zell Guano Co., Baltimore, Md.	Fruit tree invigorator.	Wolcott.	3969
Zell Guano Co., Baltimore, Md.	Genesee fertilizer.	Wolcott.	3970

lected in New York State During the Fall of 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	1.02	8	——	4	——	——
Found	1.08	10.89	12.04	3.37*	1.03	6.40
Below guarantee				0.63		
Guaranteed	1.64	8	——	4	——	——
Found	1.38	11.54	13.24	2.75*	0.60	7.59
Below guarantee	0.26			1.25		
Guaranteed	——	13	——	3	——	——
Found		15.10	15.34	3.21		11.68
Guaranteed	1.23	10	——	3	——	——
Found	1.22	10.77	11.68	3.35	0.60	8.39
Guaranteed	1.85	9	——	4	——	——
Found	1.85	9.69	10.90	4.30	0.94	7.11
Guaranteed	0.82	10	——	3	——	——
Found	1.13	10.18	12.47	3.59	0.53	4.83
Guaranteed	0.82	8	——	2	——	——
Found	0.98	9.53	12.08	2.72	0.28	3.16
Guaranteed	——	13	15	——	——	——
Found		14.20	16.90			12.35
Guaranteed	0.80	9	——	2	——	——
Found	0.97	10.24	13.11	2.37	0.02	6.40
Guaranteed	——	10	12	8	——	——
Found		10.88	13.39	7.55		7.83
Below guarantee				0.45		
Guaranteed	2.05	8	10	2	——	——
Found	1.12	10.32	11.68	2	0.26	7.79
Below guarantee	0.93					

*Potash present in form of sulphate.

RESULTS OF ANALYSES OF COMMERCIAL FERTILIZERS COL-

MANUFACTURER.	Trade name or brand.	Locality where sample was taken.	Station number.
Zell Guano Co., Baltimore, Md.	Seneca Co. special.	Ovid.	3885
Zell Guano Co., Baltimore, Md.	Special grain fertilizer.	Clyde.	3989
Zell Guano Co., Baltimore, Md.	Special high-grade potato manure.	Wolcott.	3971
Zell Guano Co., Baltimore, Md.	Special high-grade wheat fertilizer.	Ovid. North Sparta.	3886 4026
Zell Guano Co., Baltimore, Md.	10 and 10.	Owasco.	3847
Zell Guano Co., Baltimore, Md.	Wilson's special No. 1.	York.	4029

lected in New York State During the Fall of 1897.

	Pounds of nitrogen in 100 pounds of fertilizer.	Pounds of available phosphoric acid in 100 pounds of fertilizer.	Pounds of total phosphoric acid in 100 pounds of fertilizer.	Pounds of water-soluble potash in 100 pounds of fertilizer.	Pounds of water-soluble nitrogen in 100 pounds of fertilizer.	Pounds of water-soluble phosphoric acid in 100 pounds of fertilizer.
Guaranteed	0.80	10	———	5	———	———
Found	0.91	11.55	13.37	4.85	0.09	9.08
Guaranteed	0.82	8	10	4	———	———
Found	2.89	8.69	10.92	2.51	1.19	6.41
Below guarantee				1.49		
Guaranteed	3.25	6	8	8	———	———
Found	2.56	7.67	10.48	6.26	0.94	4.32
Below guarantee	0.69			1.74		
Guaranteed	1.60	10	———	5	———	———
Found	1.76	11.44	12.65	5.18	0.62	8.98
Guaranteed	———	10	12	10	———	———
Found		11.84	13.49	9.94		9.87
Guaranteed	0.80	8	10	4	———	———
Found	0.96	9.76	11.64	3.80	0.08	7.84

III. CONDITIONS REQUIRED FOR THE SUCCESSFUL GROWTH OF SUGAR BEETS.*

L. L. VAN SLYKE.

SUMMARY.

The following elements determine whether sugar beets can be grown at a profit: (1) Richness in sugar; (2) purity of solids; (3) yield of beets; (4) cost of crop; (5) market price.

(1) Richness in sugar. Analyses of about 140 samples of beets grown in different parts of New York State during 1897 show a variation of sugar in the beets from below 12 to over 18.5 per cent, with a general average of 15.3 per cent. This average is somewhat higher than shown by other states.

The following conditions exercise a marked influence upon the development of sugar in beets: Climate; variety of beet; quality of seed; kind and quantity of plant food; soil; methods of cultivation; size of beets; and time of planting and harvesting.

(2) Purity of solids. The coefficient of purity is the proportion or percentage which the sugar constitutes of the total solids in the juice, and is found by dividing the per cent of sugar in juice by the per cent of total solids in juice. The higher the coefficient of purity, the larger will be the proportion of sugar crystallized out in manufacture. The purity is influenced by maturity of beet, kind of fertilizers used, size of beet and portion of root. Immature beets contain sugar of low purity, also beets grown with excess of highly nitrogenous manures. The sugar in large beets has a lower coefficient of purity than in smaller beets. The portion of beet growing above surface of soil has

* Partial reprint of Bulletin No. 135.

NOTE.—For the most comprehensive treatise published, the reader is referred to Farmers' Bulletin No. 52 on "The Sugar Beet," by H. W. Wiley, Chief of the Division of Chemistry, U. S. Department of Agriculture, Washington, D. C.

sugar of inferior purity. The coefficient of purity in the samples analyzed varied from below 75 to over 87, with an average of 82.5.

(3) Yield of beets. Twenty tons of marketable beets an acre may be regarded as a maximum yield in commercial operations. An average of 10 to 12 tons an acre may probably be expected in favorable seasons in this State.

(4) Cost of production. The cost of raising an acre of sugar beets may be placed between $40 and $50, when all conditions are favorable.

(5) Market price and profits. There is good reason to expect that beets will bring from $4 to $5 a ton according to varying conditions of sugar, purity, etc. In general, a profit of $5 to $10 an acre above all expenses may be regarded as a reasonable expectation from the crop.

(6) General considerations. The sugar beet is to be grown as an added crop with a comparatively small acreage at the beginning, increasing as conditions favor. The educational value derived from growing sugar beets is considerable. A farmer who learns to grow sugar beets well will grow other crops better for the experience. The soil on which sugar beets have been grown is left in better mechanical condition than by other crops.

INTRODUCTION.

The growing of sugar beets for the production of sugar is, at the present time, attracting more attention in our State than any other subject connected with agriculture. Farmers are asking for reliable information in regard to those various phases of the subject which possess special interest for them. They want to know whether the soil and climate of our State are adapted to the successful raising of sugar beets; whether they may have a reasonable assurance of a fair profit, compared with other crops grown by them; and whether there is any degree of certainty that they may be sure of a cash crop and a steady market. The chief elements which determine whether sugar beets can be grown at a profit are the following:

I. Richness in sugar.
II. Purity of solids.
III. Yield of beets an acre.
IV. Cost of raising and transporting crop.
V. Market price and profits.
VI. General considerations.

I. RICHNESS IN SUGAR.

When beets were first used as a source of sugar, the amount of sugar contained in them averaged about 6 per cent. As a result of careful selection and breeding during a period of many years, the amount of sugar has been increased to an average lying between the limits of 12 and 15 per cent. Many crops of beets show a sugar content of over 15 per cent, while in some exceptional cases, the sugar has been reported as high as 20 per cent and even higher in this State. Farmers must avoid the mistake of regarding exceptional cases as typical. When all the details are known about remarkably high yields of sugar in beets, it is usually found that special conditions exist which cannot readily be duplicated in commercial operations. The question of interest to each farmer pertains to the results he can secure on his farm, working under the conditions involved in growing beets on a commercial scale. From results secured by this Station during the past year with beets grown in various sections of the State, we can present data which ought to be of value in showing how much sugar has been obtained in beets.

Before presenting a summary of our data, we will explain certain terms which it will be necessary to use. In using the term "sugar," we mean the crystallizable sugar that goes by the chemical name of sucrose. The amount of sugar is stated in two ways: "Sugar in beet" and "sugar in juice." One hundred pounds of sugar beets contain, on an average, about 95 pounds of juice, and so the sugar in 100 pounds of beets is contained in 95 pounds of juice. Therefore, the juice is more concentrated with respect to

sugar, and when the results are expressed in percentages, the number expressing the per cent of sugar is higher in the juice than in the beet.

We present below in tabulated form the results obtained in making analyses of about 140 samples of sugar beets grown in this State during 1897:

Results of Analyses of Sugar Beets Grown during the Season of 1897.

Variety of beet.	Amount of sugar in beet.	Number of samples.	Average amount of sugar in beet.	Average amount of sugar in juice.	Average amount of total solids in juice.	Average co-efficient of purity of juice	Average weight of one beet.
	Per ct.		Per ct.	Per ct.	Per ct.		Ozs.
Klein Wanzlebener	11 to 12	4	12	12.7	16.6	76.5	20
Klein Wanzlebener	12 to 13	11	13	13.7	18.3	75.4	18
Klein Wanzlebener	13 to 14	10	13.8	14.5	18.3	80.0	14
Klein Wanzlebener	14 to 15	11	14.7	15.5	19.3	80.3	17
Klein Wanzlebener	15 to 16	15	15.8	16.6	19.7	84.3	14
Klein Wanzlebener	16 to 17	11	16.5	17.4	20.4	85.3	16
Klein Wanzlebener	17 to 18	13	17.6	18.5	21.7	85.2	14
Klein Wanzlebener	18 to 19	3	18.5	19.5	22.7	85.9	13
Vilmorin Improved	11 to 12	3	11.7	12.3	16.4	75.0	16
Vilmorin Improved	12 to 13	5	12.8	13.5	17.6	76.7	24
Vilmorin Improved	13 to 14	9	13.8	14.5	17.6	82.4	19
Vilmorin Improved	14 to 15	8	14.8	15.6	18.8	83.0	16
Vilmorin Improved	15 to 16	17	15.6	16.4	20.0	82.0	16
Vilmorin Improved	16 to 17	9	16.6	17.5	20.0	87.5	15
Vilmorin Improved	17 to 18	6	17.8	18.7	21.9	85.4	18
Vilmorin Improved	18 to 19	2	18.6	19.6	23.4	83.8	24

Summary.

Klein Wanzlebener	....	78	15.3	16.1	19.6	82.2	15½
Vilmorin Improved	....	59	15.3	16.1	19.4	83.0	17⅓
Average of all	....	....	15.3	16.1	19.5	82.5	16½

Below we present general averages of some of our results giving figures for several different counties. While these results are of interest, they possess little real value so far as they represent general conditions, because we have received too few samples from most counties to afford any fair basis for comparison. Readers are carefully cautioned against drawing any sweeping conclusions from the results presented in this manner.

RESULTS OF ANALYSES OF SUGAR BEETS GROWN IN DIFFERENT COUNTIES.

COUNTY.	Amount of sugar in beet.	Amount of sugar in juice.	Co-efficient of purity.
	Per cent.	Per cent.	
Albany	16.2	17.1	81
Broome	14.3	15	81.1
Cayuga	12.9	13.6	74
Chautauqua	14.7	15.5	82.4
Clinton	15.7	16.5	80.5
Columbia	16	16 8	82
Cortland	14.4	15.2	79.6
Erie	15.5	16.3	82.3
Genesee	14.1	14.8	79.2
Lewis	14.8	15.6	83.8
Madison	15.7	16.5	82.5
Monroe	15.2	16	86.5
Oneida	15.4	16.2	83.5
Ontario	15.5	16.3	82.3
Orleans	14.6	15.4	84.2
Oswego	14.3	15.1	87.3
Otsego	16.3	17.2	86.9
St. Lawrence	16.1	17	84.2
Wyoming	14.7	15.5	81.6

A few results are not inserted in the foregoing table, because the beets were considerably dried when received and the results were unduly high and misleading.

From these data it would appear that in making estimates, farmers would be wisely conservative in basing their calculations upon beets containing an average not exceeding 15 per cent of sugar. Disappointment will await most of those who, never having grown sugar beets, expect profits from the industry based upon figures that are much above the average actually obtained. It must also be kept in mind that the season of 1897 in New York was most favorable for beet growing and the results secured probably represent conditions better than average.

The average percentage of sugar in beets, as reported in other states, is as follows:

AVERAGE PERCENTAGE OF SUGAR IN BEETS GROWN IN DIFFERENT STATES.

STATES.	Sugar.	
	In beets.	In juice.
	Per cent.	Per cent.
California, average for five years	14.2	14.9
Utah, average for five years	12.2	12.8
Nebraska, average for five years	12.8	13.5
Oregon	14.2	14.9
Washington	14.	14.7
Wisconsin	11.8	12.4

CONDITIONS INFLUENCING AMOUNT OF SUGAR IN BEETS.

Numerous conditions exercise a marked influence upon the development of sugar in beets. Among the most important, we may mention the following:

1. Climate.
2. Variety of Beet.
3. Quality of seed.
4. Plant-food.
5. Soil.
6. Methods of cultivation.
7. Size.
8. Time of planting and harvesting.

1. CLIMATE.

Temperature.—According to extended experience, it has been shown that the highest amount of beet sugar is commonly obtained in places whose mean summer temperature is about 70° F.

Rainfall.—The amount of rainfall most favorable to the development of sugar in beets is from two to four inches a month during the summer. Midsummer drought works injury to the development of sugar beets. Rains after the crop has matured and before it is harvested may start a new growth of the beets, by which the percentage of sugar is materially lowered.

Sunshine.—An abundance of sunshine also is essential to the largest development of sugar in beets.

Most of the tillable portions of New York practically fulfil the climatic conditions required for a satisfactory development of sugar in beets.

2. VARIETY OF BEET.

The amount of sugar present in a beet varies, to some extent, with the variety of beet grown. Taking standard varieties, we find greater differences in the sugar content of the same variety grown under different conditions than we do of different varieties grown under uniform conditions. The varieties most commonly grown the past year in this State have been Vilmorin Improved and Klein Wanzlebener. Several other varieties have been grown at this Station. We give below a tabulated statement showing the per cent of sugar contained in different varieties of beets grown during the season of 1897.

SUGAR IN DIFFERENT VARIETIES OF BEET.

VARIETY.	Average amount of sugar in beet. Per cent.
Klein Wanzlebener	15.3
Vilmorin Improved	15.3
Klein Wanzlebener (grown at Geneva)	15.7
Vilmorin Improved (grown at Geneva)	15.5
Demesmay (grown at Geneva)	12.2
Vilmorin Elite (grown at Geneva)	14.5
Vilmorin's La Plus Riche (grown at Geneva)	16.6

3. QUALITY OF SEED.

The importance of using only highly bred seed cannot be overestimated. In Europe the production of sugar-beet seed has become a separate branch of industry. Carefully selected and tested beets containing from 16 to 18 per cent of sugar and of high purity are used for this purpose.

4. PLANT FOOD.

Kinds and amounts.—It is safe to assume that sugar beets cannot be successfully grown on many farms in this state for any considerable length of time without the application of plant-food.

Analyses of sugar-beet roots show quite a wide range of variation in respect to fertilizing constituents, as may be roughly indicated in the subjoined table:

FERTILIZER CONSTITUENTS IN SUGAR BEETS.

CONSTITUENTS.	POUNDS IN 2,000 POUNDS OF SUGAR BEETS.	
	Variation.	Average.
	Pounds.	Pounds.
Nitrogen	3 to 5	4
Phosphoric acid	1 to 3	2
Potash	6 to 8	7
Lime	1 to 1½	1¼
Magnesia	1 to 1½	1¼

In basing upon the preceding average the composition of a fertilizer to be used in growing sugar beets, one may plan to use approximately the amount of nitrogen indicated, considerably more phosphoric acid than the analysis gives and a little more potash than is shown by analysis. As a rule, most of our soils contain enough lime and magnesia. As a general guide, we can suggest for use in fertilizing sugar-beet crops a mixture containing

Nitrogen .... 4 per cent.
Available phosphoric acid .... 6 per cent.
Potash .... 9 per cent.

One hundred pounds of a fertilizer having this composition would supply plant-food needed for the growth of one ton of marketable beet roots. It is probable that in most cases the application of 1,000 pounds of such a fertilizer on each acre of land would satisfactorily maintain fertility, assuming that the soil was supplied with some available plant-food at the start. With large yields of beets, more than 1,000 pounds of such fertilizer might be required ultimately.

The foregoing estimates are based upon the supposition that all portions of the crop are returned to the soil, except the roots sold to the sugar factory. If the leaves and crowns are not left for the soil, the amount of fertilizer to be applied will need to be increased considerably, since these parts are much richer in plant-food materials than the marketable roots.

Available sources of plant-food.—Stable-manure, well rotted, has been extensively used with good results. It should be used with caution, however, as will be indicated later. It must be remembered also that the exclusive and continuous use of rich stable-manure may ultimately result in a one-sided nitrogenous fertilization and a gradual exhaustion of phosphoric acid and potash from the soil. Nitrogen can be supplied by stable-manure, nitrate of soda, sulphate of ammonia, fish-scrap, cottonseed meal, bone meal, or slaughter-house refuse, such as dried blood and tankage. Phosphoric acid can be furnished in the form of acid phosphate, bone meal, dissolved bone, etc. Potash can be supplied in any of the forms common in commerce and also by means of the molasses residue of beet-sugar factories. When lime is known to be needed, it can be supplied in the form of quicklime, land-plaster, ground shells, etc. Magnesia, when needed, can be furnished by the press-cake of sugar factories or in the form of German double sulphate of potash and magnesia.

Mixtures of plant-food.—The following mixtures of high-grade materials are offered as suggestions or illustrations of what could be used, the amounts given being for one acre of land:

MIXTURE NO. 1.

Nitrate of soda	60 pounds.
Dried blood	200 pounds.
Fish-scrap	150 pounds.
Acid phosphate	400 pounds.
Sulphate or muriate of potash	180 pounds.

MIXTURE NO. 2.

Bone meal	500 pounds.
Sulphate of ammonia	100 pounds.
Sulphate or muriate of potash	180 pounds.
Acid phosphate	100 pounds.

MIXTURE NO. 3.

Stable manure, well-rotted, 8,000 pounds or more applied to the crop preceding the beets, supplemented by bone meal, 500 pounds (or acid phosphate, 300 pounds), and sulphate or muriate of potash, 180 pounds.

The phosphoric acid and potash can be applied to the soil at the time of putting in the beet crop.

The cost of these mixtures will probably average from $10 to $15 for 1,000 pounds. In purchasing plant-food materials farmers must be governed by the market conditions prevailing at the time of purchase and by other economical considerations.

Special Suggestions.—(1) Time of application. Stable-manure and other similar materials are best applied to the crop preceding the beet crop. Readily available forms of plant-food can be applied to the soil when the crop is put in or just before.

(2) Precautions. Excessive application of stable-manure or other nitrogenous materials should be avoided, in order to secure beets of good quality. Well-rotted is preferable to fresh stable-manure.

(3) Rotation. Beets will, as a rule, give best results in respect to sugar, when grown in rotation with other crops. It is wise not to grow more than two crops in succession on the same soil. A plan of rotation suggested by Dr. Wiley is wheat, beets and clover, one crop of which is cut for hay and the second crop turned under, this to be followed by potatoes, wheat and beets. Beets do best after some cereal.

5. Soil.

As a rule, good sugar beets can be grown on any soil which will produce a satisfactory crop of wheat, corn or potatoes. Fairly level soil, well drained, is essential for best results.

6. Methods of Cultivation.

Of the conditions under the farmer's control, requisite to success in growing sugar beets of high quality, there is none of greater importance than the methods employed in preparing and cultivating the soil. Plowing should be done in the late autumn to the depth of not less than 9 inches. A subsoiler should follow the plow, loosening the soil 6 or 7 inches deeper, thus giving a total depth of 15 inches or more. In the spring only the surface needs preparation, and this should be put in very fine tilth immediately before planting. The thinning should be done promptly when four leaves show.

During 6 to 8 weeks of the growing season, the soil should be cultivated once a week at least and in dry seasons more frequently. There is probably none of our common crops which is more exacting than the sugar beet in its demands for careful, prompt and regular attention, if satisfactory results are to be realized.

7. SIZE OF BEETS.

Large beets are inferior for sugar production. The size yielding most sugar weighs from one to two pounds, though factories do not usually reject beets weighing as much as three pounds. The beets which have come under our observation have varied in weight from seven ounces to three pounds and twelve ounces, the average being a fraction of an ounce over one pound.

8. TIME OF PLANTING AND HARVESTING.

The main consideration to be kept in mind in this State in respect to time of planting sugar beets, is to allow sufficient time for complete maturing. Taking our seasons as they average, the planting can usually be done in May. In planting later than June 1, much risk is incurred in reference to the proper ripening of the crop.

Before harvesting, the beets should ripen completely, since immature beets contain less sugar than the ripe ones. At maturity the leaves turn yellowish green and the outer ones bend down about the beet. It requires about 150 days for a crop to develop its highest sugar content, varying, of course, with the character of the season. Harvesting must take place before the second growth commences, since this decreases the amount of sugar.

II. PURITY OF SOLIDS IN JUICE.

While the percentage of sugar contained in a beet is highly important, it is not the only factor that determines the quality of the beet. The *purity* of the solids in the sugar-beet juice must be considered also. Beet juice contains besides sugar other substances in solution. To illustrate, the juice of a certain sample of sugar beets contains 12.8 per cent of sugar and 18.2 per cent of total solids, including sugar and other materials. This leaves 5.4 per cent of solids not sugar. Having the per cent of sugar and the per cent of total solids, how do we state the purity of the juice? We divide the per cent of sugar (12.8) by the per cent of total solids (18.2) and the product, expressed in parts per hundred, is 70; and this we call the "Coefficient of Purity," which may be

defined as the proportion or percentage which the sugar constitutes of the total solids in the juice. Thus, in the illustration given, of 100 parts of total solids in juice, the sugar forms 70 parts.

Why is the coefficient of purity regarded as an important element in determining the quality of sugar beets? Because the portion which is not sugar prevents complete crystallization and recovery of the sugar in the process of manufacture. Experience has shown that for each pound of non-sugar solids, one pound of sugar is not recovered from the juice. In the illustration used above, we have in 100 pounds of juice 12.8 pounds of sugar and 5.4 pounds of non-sugar solids. Then, in this case, we should expect to recover only 7.4 pounds of sugar from the 12.8 pounds present in the juice.

To give another illustration, 100 pounds of juice contains 17.3 pounds of sugar and 19.8 pounds of total solids. The coefficient of purity is 87.5 and the amount of non-sugar solids is 2.5 pounds. From 100 pounds of such juice, 14.8 pounds of sugar could be recovered.

As a rule, sugar is recovered to the extent of 70 pounds for 100 pounds of sugar in the beet root.

From the preceding statements, the importance of the purity of beet juice can be appreciated as an element in determining the practical value of sugar beets for sugar production.

The tabulated statement on page 191 shows the results obtained by us in our season's work.

Conditions Influencing Coefficient of Purity.

Most of the conditions which affect the percentage of sugar contained in beets also influence the coefficient of purity. Among conditions specially to be mentioned are the following:

1. Maturity.
2. Fertilizers.
3. Size.
4. Portion of root.

1. MATURITY.

Unripe beets contain a large proportion of non-sugar solids and hence a lower coefficient of purity than ripe beets. Such beets have, therefore, a smaller proportion of sugar that can be recovered.

2. FERTILIZERS.

The excessive application of stable-manure or other nitrogenous fertilizers lowers the coefficient of purity. Soils containing a large amount of organic matter, like drained swamp lands, and recently cleared forest lands, produce beets having a low coefficient of purity.

3. SIZE.

The size of beets is often closely associated with the amount of nitrogenous plant-food employed. Excessive use of such manures tends to produce a rapid, rank growth of beets, large in size but poor in quality, especially in respect to coefficient of purity. Too great distance between roots in soil also tends to promote growth in size at the expense of quality.

4. PORTION OF ROOT.

The neck or crown of the beet root contains large amounts of non-sugar solids. The entire portion of the beet growing above ground is rich in those solids producing low coefficient of purity. It is, therefore, important to have the root grow above ground as little as possible.

III. YIELD OF BEETS.

A very important element to be considered by the farmer who plans to raise sugar beets is the yield. However high in quality sugar beets may be, it is necessary to secure a good yield of roots in order to realize satisfactory money returns. Reliable data appear to indicate that we may regard 20 tons of marketable sugar beets of high quality as the largest yield an acre that can be realized in commercial operations. Yields are often reported exceeding 25 and 30 tons an acre, but such returns are open to suspicion, so far as they represent commercial conditions. Misleading yields are often obtained by weighing and counting the

beets covering a definite small area and basing the estimate for an acre on the data so obtained. Another method employed in figuring out large yields is to obtain the average weight of a few beets and then assume that an acre contains forty thousand beets, each having the same weight as the average obtained. Moreover, reports of yields are often based on results secured in growing a fraction of an acre of beets under conditions which are more favorable than those met in working with several acres.

To obtain the fairest idea of yield under commercial conditions, we can do no better than to study the results furnished by actual operations where sugar beets have been successfully grown for a period of years on a commercial scale. Below we present results reported by the sugar-beet factory at Lehi, near Salt Lake City, Utah, and by the Chino Valley Beet Sugar Company, in Southern California, and also some data derived from German sources.

Yield of Marketable Beets Grown on One Acre.

Reports given by	1891.	1892.	1893.	1894.	1895.	Average.
	Tons.	Tons.	Tons	Tons.	Tons.	Tons.
Factory at Lehi, Utah	6.6	6.5	9.7	11.47	11.54	9.16
Chino Factory, Southern California	7.26	7.5	11.7	9.16	11.03	9.33
German factories	12.8	11.2	11.0	13 0	12.4	12 1

There is no reason to believe that the average New York farmer will secure results largely in excess of those reported above. If an average yield of 10 tons an acre can be secured at the start, our farmers will realize larger returns than did those of California and Utah during the first years of their experience. The table above is encouraging in that it shows steady progress on the part of the farmers in securing larger yields. The commercial experience of others should impress our farmers that they are not to expect exceptionally large returns the first year, for this is likely, in the very nature of the case, to prove the poorest in yield; but acquired experience should bring with each year an increased yield. During the past season we secured a yield of 15.1 tons of marketable beet roots an acre on the Station farm.

Those factors which influence the quality of the sugar beet also affect the yield more or less, among which are the variety of beet grown, quality of seed, distance between plants, soil, cultivation, season, etc.

In this connection may be considered the amount of pure sugar produced an acre. Using the same sources of information as those given above, we have the following table:

YIELD OF PURE SUGAR FROM SUGAR BEETS GROWN ON ONE ACRE.

REPORTS GIVEN BY	1891.	1892.	1893.	1894.	1895.	Average.
	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.
Factory at Lehi, Utah	1,162	1,227	1,719	2,336	2,539	1,797
Chino Factory, Southern California	1,510	1,680	2,621	2,198	2,670	2,136
German factories	......	......	3,276	3,149	3,514	3,313

It is a matter of much interest to note that the yield of sugar an acre increased quite rapidly from year to year in the Utah and California factories. This was due not only to an increase in yield of beets, but to an increase in the per cent of sugar and coefficient of purity.

Taking the averages obtained by our analyses and assuming the average yield of marketable beet roots to be 10 tons an acre, we estimate that, under these conditions, there would be a yield of about 2,400 pounds of commercial sugar.

IV. COST OF RAISING AND TRANSPORTING CROP.

Numerous factors enter into the cost of raising sugar beets and these will vary in different places. Among such factors may be mentioned the value of land, the cost of labor and the extent to which hand labor and machine labor are employed. Some of the details of this subject are discussed hereinafter, when data are given derived from actual experience in raising beets on the Station farm. It may be regarded as a conservative estimate to place the price at which beets can be grown in New York under favorable conditions between the limits of $40 and $50 an acre.

The cost of transporting the crop from the farm to the factory

must also be considered. The accessibility of a factory is a primary condition which will by itself determine the practicability of raising sugar beets. The cost of transportation is an item which must be calculated by each farmer for the conditions existing in his particular case.

V. MARKET PRICE AND PROFITS.

Provided a factory is accessible, there is a good degree of certainty that for years to come there will be a sure market for all the beets raised. It cannot be foreseen definitely what unexpected conditions may arise to affect seriously the price to be paid for beets, but good beets ought to bring the farmer not less than $4 a ton and from this up to $5. In general, a profit from $5 to $10 an acre above all expenses may be regarded as a fair return from the crop.

VI. GENERAL CONSIDERATIONS.

The sugar-beet crop is to be regarded as an additional one, to which a farmer, properly located, may give a portion of his time. It is not intended to take the place of other crops which one knows can be successfully grown. In commencing, farmers will be wise to limit their crop to one or two acres and increase it only as they see their way clear to do so.

The educational value to be derived from growing sugar beets properly can hardly be overestimated. The exacting demands of its successful culture require the best kind of farming. It is reasonable to assume that a farmer who grows sugar beets well will be likely to grow his other crops better than he did before raising beets.

In addition, it is to be remembered that the soil on which a crop of sugar beets has been grown is left in better mechanical condition than by other crops and that it is in better condition for growing other crops.

REPORT

OF THE

HORTICULTURAL DEPARTMENT.

S. A. BEACH, M. S., Horticulturist.

WENDELL PADDOCK, B. S., First Assistant.

C. P. CLOSE, B. S., Assistant.

Table of Contents.

REPORT OF THE HORTICULTURIST.

S. A. BEACH.

I. TREATMENT OF LEAF SPOT IN PLUM AND CHERRY ORCHARDS IN 1896.*

SUMMARY.

The following report of the work in treating the leaf spot disease of plum and cherry in 1896 is intended as a sequel to Bulletin 98 which contains an account of the work in 1895.

Work with Plums.

The questions investigated in 1896 were:

(1) Can the disease be controlled with two treatments of Bordeaux mixture 1 to 11?

(2) If but two or three treatments are to be made when should they be given?

In the case of Italian Prune, on which variety the disease was most prevalent, the best results came from three treatments made May 25, June 17 and July 14.

The experiments indicate that if but two or three treatments are made the first should be given during the last week of May, or about ten days after the blossoms fall, and the second about three weeks later.

In seasons when the disease is no worse than it was in 1896 it may be practically controlled by two sprayings.

These experiments show an average increase in the yield of sprayed Italian Prunes of 24½ lbs. per tree at a cost of less than one cent per pound.

Work with Cherries.

On orchard trees of Montmorency sprayed with Bordeaux mixture May 14, May 29 and June 15, 1895, only a slight amount of

*Reprint of Bulletin No. 117.

rot was found, while on adjacent trees of the same variety which were not sprayed, from one-twentieth to one-fifth of the fruit rotted.

On orchard trees of Montmorency sprayed June 15, 1895, with eau celeste soap mixture, only a slight amount of rot was found, while on adjacent unsprayed trees from one-twentieth to one-fifth of the fruit rotted.

From the middle of June, 1895, till the close of the season the unsprayed trees had much more and better foliage than did the trees which had been sprayed.

Generally the injury to the leaves in 1895 was much greater on the trees which were sprayed with eau celeste than it was on the trees sprayed with Bordeaux mixture but on one group of Reine Hortense the Bordeaux mixture caused the greater injury.

No injury to the leaves resulted from spraying orchard trees with Bordeaux mixture in 1896, even when they were drenched with it.

Bordeaux mixture applied as late as May 25 is liable to show on the fruit when it is ripe and injure its appearance.

INTRODUCTION.

The leaf spot disease of plum and cherry was less destructive in New York orchards in 1896 than it has been in some former years, yet in some instances it did considerable damage to certain kinds of plums. Instances were also reported in which cherry trees lost a good deal of foliage by it, but usually they were troubled but little.

The character and appearance of this disease are explained in Bulletin 98 which contains an account of the investigations in treating it which were made by this station in 1895. As there stated, the objects of the investigations were:

1. To compare Bordeaux mixture with eau celeste soap mixture for preventing the disease on bearing trees.

2. To learn what is the fewest number of treatments by which the disease may be controlled and the best time for making them.

The results of the experiments with plums will first be considered.

TREATMENT OF THE DISEASE ON BEARING PLUM TREES.

The investigations in 1895 showed that while the treatment with the eau celeste checked the disease it injured the foliage. The treatment with Bordeaux mixture did just as much good, or even more, in checking the disease, and it did not hurt the foliage. There was no good chance to compare these two remedies in August, either in 1895 or 1896, as the trees did not show enough injury early in August to permit of a satisfactory comparison of the two remedies. In the latter part of August and in September and October the good effects of the early spraying which was done in May and June showed very plainly. It seems probable that if the early treatments are thoroughly made there will be little need of spraying in August. Should August treatment be found necessary eau celeste might be preferable because it is less liable to show on the ripe fruit, but we are not prepared to say that it is preferable.

The Bordeaux mixture was so much superior to the eau celeste in the trials which were made in 1895 that no experiments in comparing the two mixtures for early treatment were made in 1896.

The investigations as to the fewest number of treatments with Bordeaux mixture, 1 to 11,* necessary to control the leaf spot on bearing plum trees and the best time for making them, were continued in 1896 in the same orchard of T. C. Maxwell & Bros. which was kindly offered to the Station for this purpose in 1895. The treatment gave marked results, especially with Italian prune, and to a large extent confirmed the results of the work in 1895. The weak Bordeaux mixture, 1 to 11, again proved entirely satisfactory and it is confidently recommended for treating plum leaf spot.

Plan of the work in 1896.—Four series of treatments were compared, namely:

Series 1. Italian Prune, Guii and Lombard were sprayed May 14, June 3 and June 17. The first treatment, May 14, was given soon after the blossoms fell.

*The 1 to 11 formula for Bordeaux mixture requires one pound sulphate of copper to make eleven gallons of the mixture.

Series 2. Italian Prune, Guii and Lombard were sprayed May 25 and June 24.

Series 3. Italian Prune and Lombard were sprayed May 25, June 17 and July 14. Guii was not included in this series for it ripened its fruit in August and the last application July 14 would be liable to show on the ripe fruit.

Series 4. Guii sprayed May 25 and June 17.

One hundred and sixty-eight trees were included in these experiments, so it appears that the tests were sufficiently extended to insure reliable results.

Results.—Through the early part of the season the trees, whether sprayed or not, showed but little of the leaf spot. Later the disease became more noticeable, especially on the Italian Prune. With this variety the trees in Series 2 showed a little more injury than corresponding trees in Series 1 and 3 but were far superior to the unsprayed trees.

As early as August 12 the ground under many of the unsprayed Italian Prune was thickly strewn with fallen leaves and in consequence of this loss of foliage the fruit was prematurely ripening and dropping. At this time the unsprayed Guii trees had lost some leaves but unsprayed Lombard were in nearly as good condition as the sprayed Lombard.

October 3 a careful estimate of the amount of loss or injury to foliage was made from which the following summary is derived.

INJURY UPON SPRAYED AND UNSPRAYED PLUMS.

	Amount of Injury.		
	Italian Prune.	Lombard.	Guii.
	Per cent.	Per cent.	Per cent.
Series 1. Treated May 14, June 3 and June 17	1 to 5; average about 3.	About 10.	About 6.
Not treated	50 to 90.	About 10.	About 15.
Series 2. Treated May 25 and June 24	Average about 6.	About 3.	About 10.
Not treated	50 to 90.	About 25.	About 15.
Series 3. Treated May 25, June 17 and July 14	Average about 2.	About 5.	
Not treated	50 to 90.	About 10.	
Series 4. Treated May 25 and June 17	....	....	About 3.
Not treated	....	....	About 15.

An examination of this table shows that in the case of Italian Prunes the best results came from the three treatments given in Series 3, namely May 25, June 17 and July 14. The experiments of 1895 showed that when no more than three sprayings are given during the season it is not best to begin before the trees blossom but rather make the first spraying after the blossoms fall. The experiments of 1896 indicate that it is better to put off the first treatment till the last week of May, or till about ten days after the blossoms fall.

The attempts to control the disease with two treatments which were tried in 1895 and 1896 show that when the disease is no worse than it was in those years it may be practically controlled by two treatments; but it is hardly safe to recommend this plan unqualifiedly till it has stood the test of a season when the attacks of the leaf spot fungus are unsually sèvere.

In view of the results of the investigations of 1895-6, the following line of treatment is confidently recommended, instead of that which was suggested on page 14 of Bulletin 98.

Course of treatment recommended for plum leaf spot.—When but two treatments are to be made during the season, let the first be given about ten days after the blossoms fall—that is, usually about May 25. It should not be made later than June 1. Make the second treatment about three weeks after the first. Better results may be expected from three treatments and three treatments are especially recommended in seasons when the disease is very abundant. Make them as follows:

First. About ten days after the blossoms fall.

Second. About three weeks after the first.

Third. From three to four weeks after the second.

YIELD OF FRUIT INCREASED BY SPRAYING FOR THE PLUM LEAF SPOT.

Aside from the results bearing directly on the questions under investigation in 1895 and 1896 the experiments in treating plums for the leaf spot brought out some very important and definite information as to the influence of such treatment on the yield of

trees which are subject to the attacks of this disease. It has already been said that the injury from the leaf spot was especially severe on the Italian Prune, sometimes called Fellenberg, a variety which usually begins to ripen here the first week of September. Of the trees of Italian Prune which were under experiment in 1896 (see page 210), 48 were sprayed and 24 were left unsprayed. As early as August 12 the ground under many of the unsprayed trees was thickly strewn with fallen leaves, and consequently the fruit was ripening and dropping prematurely, while under the sprayed trees very little fallen leaves or fruit was to be seen. The amount of fallen fruit and leaves was so much greater under the unsprayed trees that by looking at the ground one could easily tell which trees had not been sprayed.

Because the treated trees held their foliage much better, their fruit ripened later and on the whole averaged larger than the fruit on the unsprayed trees. Remembering that the later fruit, as a rule, brings better prices, it is at once apparent that the increased yield in this case does not fully represent the increase in receipts from sprayed as compared with unsprayed trees. The following is a statement of the picked fruit, drops and waste from these trees and the date of picking. The yield is measured both by nine-pound baskets and by pounds, except for the waste:

YIELD OF PLUMS FROM SPRAYED AND UNSPRAYED TREES.

DATE.	Grade.	Baskets.	Pounds.	Average pounds per basket.
	48 SPRAYED TREES.			
September 1	Picked	369	3,374	9.14
September 24	Picked	48	436	9.08
	Drops	17	181	10.65
	Waste	......	110	....
	24 UNSPRAYED TREES.			
August 25	Picked	104	897	8.63
September 12	Picked	36	427	11.86
	Drops	12	84	7.00
	Waste	......	290	....

The amount and character of the average yield per tree is as follows:

AVERAGE YIELD PER TREE.

	Sprayed.			Not Sprayed.		
	Baskets.	Pounds.	Per cent.	Baskets.	Pounds.	Per cent.
Picked fruit	8.69	79.38	93	5.83	55.17	78
Drops	0.35	3.77	4	0.50	3.50	5
Waste	......	2.29	3	......	12.08	17
Total marketable	9.04	82.15	97	6.33	58.67	83

From these records it appears that where the trees were sprayed the average yield per tree of picked fruit was increased 44 per cent, the marketable drops increased 8 per cent and the waste decreased 81 per cent. The total yield of marketable fruit as recorded in pounds was 45 per cent greater where the trees were sprayed than where they were not sprayed. The extra cost of picking, packing and hauling to market would be, in this case, 13 cents. With the apparatus used by Messrs. Maxwell & Bros. the cost of spraying would be 8 cents per tree, counting the applications which were actually made, *i. e.*, two applications for sixteen trees and three applications for thirty-two trees. Thus the extra expense of securing and putting on the market an increased yield per tree of 24.48 lbs. of fruit was only 21 cents. So it appears that spraying for leaf spot in this instance secured an average increase of 24½ pounds of marketable fruit per tree at a cost of less than one cent per pound.

TREATMENT OF THE DISEASE ON BEARING CHERRY TREES.

The experiments which have been tried by this Station during the last two years for preventing the leaf spot on bearing cherry trees have not met with very encouraging results. It was stated in Bulletin 98 that in 1895 the treatment injured the foliage. Generally speaking the eau celeste treatment caused more injury than did the Bordeaux mixture, although there was one exception to this in which Reine Hortense was more injured by the Bordeaux mixture than by the eau celeste.

The work was continued in 1896 for the purpose of learning whether heavy applications of Bordeaux mixture were more apt to harm cherry leaves than light ones, and also for the purpose of determining the fewest number of treatments necessary to control the leaf spot on bearing cherry trees and when they should be made. Mr. C. K. Scoon, Geneva, N. Y., kindly offered the use of his orchard for this work. One hundred and fifty-five trees were included in the experiment; part of them English Morello and part Montmorency Ordinaire.

But little leaf spot was seen, even on the unsprayed trees, so that but little difference could be seen between treated and untreated trees. In October a few of the latter showed more yellow and fallen leaves than did sprayed trees which stood near by, but there was not enough difference to support any conclusions as to the merits of the different methods of treatment.

Foliage not hurt by spraying.—Contrary to the experience of 1895 no injury to the foliage followed the use of Bordeaux mixture in 1896, even when the leaves were literally drenched with it. It is difficult to find any theory which offers a satisfactory explanation for the harmful effect of the Bordeaux mixture on the cherry foliage in 1895. It is the only instance in our experience in which cherry leaves have been injured by spraying with Bordeaux mixture.

Fruit spotted by the spray.—In 1896 the first treatment was given May 14, soon after the blossoms fell. The following treatment was made in one instance May 25, in another May 29 and in a third June 3. In all cases the fruit still showed the spots of Bordeaux mixture when it ripened, nearly two months later, although considerable rain had fallen in the meantime.

The results of these tests do not give conclusive evidence as to the best way to treat the leaf spot on bearing cherry trees and no definite line of treatment can as yet be recommended.

II. SPRAY PUMPS AND SPRAYING.*

WENDELL PADDOCK.

SUMMARY.

We are constantly in receipt of inquiries concerning spraying apparatus and methods of spraying, which show that elementary instruction on this subject is still needed. The following pages were prepared to meet this want, and the bulletin is addressed to those persons who are seeking such information.

Some of the spraying machinery now on the market that has been tested at this station is illustrated and described and the addresses of the firms manufacturing it are given. The formulas of the principal mixtures used in spraying are given and many necessities and conveniences are mentioned.

Important notice.—Do not spray trees or plants when in bloom. It is in no instance necessary or desirable. By so doing not only are we liable to injure the delicate parts of the flowers, but what is more important, to poison the bees and other insects that are our friends. It would be impossible to grow some of our fruits commercially without the aid of insects in fertilizing the blossoms.

INTRODUCTION.

Since spraying has become one of the operations of culture with so many farmers and fruit growers, it would seem as if explicit directions were now almost superfluous. Numerous bulletins on the subject have been issued by our experiment stations, and the pages of agricultural and horticultural papers are alive with discussions on the subject. However, that there are many localities in the State where the methods of spraying are not understood is revealed by the numerous letters of inquiry that are received at this Station.

*Reprint of Bulletin No. 121.

In order to simplify correspondence, as well as to supply a still popular demand, it was thought best to issue another bulletin on spraying machinery. Accordingly, a circular letter was sent to some of the leading manufacturers requesting them to send their pumps to the Station for testing. The majority of the firms addressed responded to the request and kindly sent their pumps free of charge.

In testing pumps it is not our purpose to try to decide what one is best, as some forms are better adapted to certain kinds of work than others. In the following pages we have tried to point out the good and bad features as they have appeared to us in our tests, so that the reader who intends to buy a spraying outfit may have a clear idea of what the pumps are like before he places his order. The illustrations are for the most part quite plain, so that extended descriptions need not be given.

Many of the hints on spraying that are given have been printed a number of times in former bulletins of this Station. However, we still receive numerous questions concerning these points, so a repetition of them will not be out of place here.

Selection of a pump.—When selecting a pump one should not have in view the cheapest one that will do good work. Almost any of the pumps now on the market will work satisfactorily for a time, but there are a number of other qualifications that should be considered. The durability, capacity, ease of working, ease with which the parts may be gotten at and repaired or replaced, and the efficiency of the agitator, are among the essentials that should be thought of.

Work intelligently.—We sometimes receive such questions as the following: "Isn't it about time for me to spray my orchard?" When the questioner is asked what he intends to spray for, perhaps the answer will be, "Oh, I don't know, only I thought it must be about time to begin." It is safe to say that such persons will not be able to see much benefit to be derived from spraying.

Occasionally inquiries are made concerning the use of Bordeaux mixture for poisoning insects, and the value of Paris green for

combating plant diseases. It cannot be too strongly emphasized that *Bordeaux mixture is used only to prevent the spread of plant diseases*, such as apple scab, though it serves as a repellent against some insects. *Paris green is used to poison insects that chew their food*, as do the potato beetle and the canker worm. *Kerosene emulsion is used to kill insects that suck their food*, as do plant lice and scales.

This brings to mind the man who has sprayed and complains that he can see no benefit resulting from his labor. Such complaints can usually be attributed to one of two causes. Either the work was not properly done, or else insects and diseases were not present in sufficient numbers to do any appreciable amount of injury. This only helps to emphasize the fact that each person must become acquainted with these pests for himself, for in no other way can he intelligently combat them. It will not do to follow printed instructions or spray calendars too closely, for spraying cannot be done by rule, since the conditions are not the same from year to year. There are a few pests, such as the apple scab and codling moth, that are universally distributed, and we may expect attacks from them each season. It will pay to spray every season for such pests. We occasionally have seasons when the weather conditions are not suitable for the spread of insects and diseases, but they are the exception. Even in such seasons the spray will have some value, as it will tend to further diminish the spread of the pests, so that they may be more readily held in check when conditions favorable to their increase do arise. Therefore we must not conclude that spraying will not pay because we do not get flattering results in any one season, for the next year may bring conditions when our plants will most need protection.

A very little reading and study will enable any one to become familiar enough with the common insects and diseases to know them when he sees them and to learn how to combat them. The first thing to be done, then, is to find out what we are going to spray for, and how and when to apply the remedy. Bulletin No. 86 of this Station gives general directions for combating the principal fungous and insect pests, and other bulletins have been issued on

special insects and diseases at intervals as they have demanded attention. A supply of many of these is still on hand and copies may be had for the asking.

HAND MACHINES.

PUMPS.

The Eclipse.—The style of pumps illustrated in Figures 1 and 2 is a comparatively new idea in spray pumps. Though they have but recently been introduced, a large number of them are in use, and they seem to be giving satisfaction. The Eclipse, illustrated in Figure 1, was the first of the two to be put on the market. This pump is manufactured by Morrill & Morley, Benton Harbor, Mich., and is listed at $20. The illustration gives a good idea of the form of the pump. All parts that come in contach with the liquid are made of brass, and, as can be seen, the pump is placed directly in the barrel. The cylinder is at the bottom, and is made of solid brass, there being no stuffing-box. The plunger consists of a short cylinder of brass around the center of which is fitted a small amount of packing. The arrangement of the parts is such that the piston cannot work clear through the cylinder, consequently the cylinder wears more at the center that at either end. In one season's hard use we find that the wear becomes so great that sufficient packing cannot be gotten in to fill up the center of the cylinder. However, a worn-out cylinder can be quickly replaced at a cost of seventy-five cents.

The agitator, as is shown in the cut, consists of a wide spoon-shaped blade or paddle, which is fastened at one end by a hinge to the lower end of the cylinder. A rod connecting with the pump handle moves the blade up and down with every stroke. This device is quite satisfactory.

The air chamber surrounds the discharge pipe, and is of sufficient capacity to insure a steady spray.

When the cylinder or plunger needs attention the pump must be taken from the barrel, but this is not a difficult task, since the pump is removed by unscrewing two bolts that are entirely

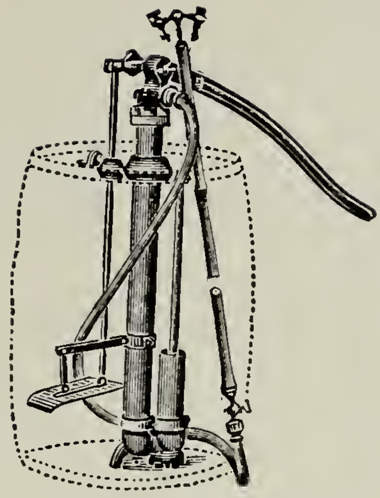


FIG. 1.—THE ECLIPSE.

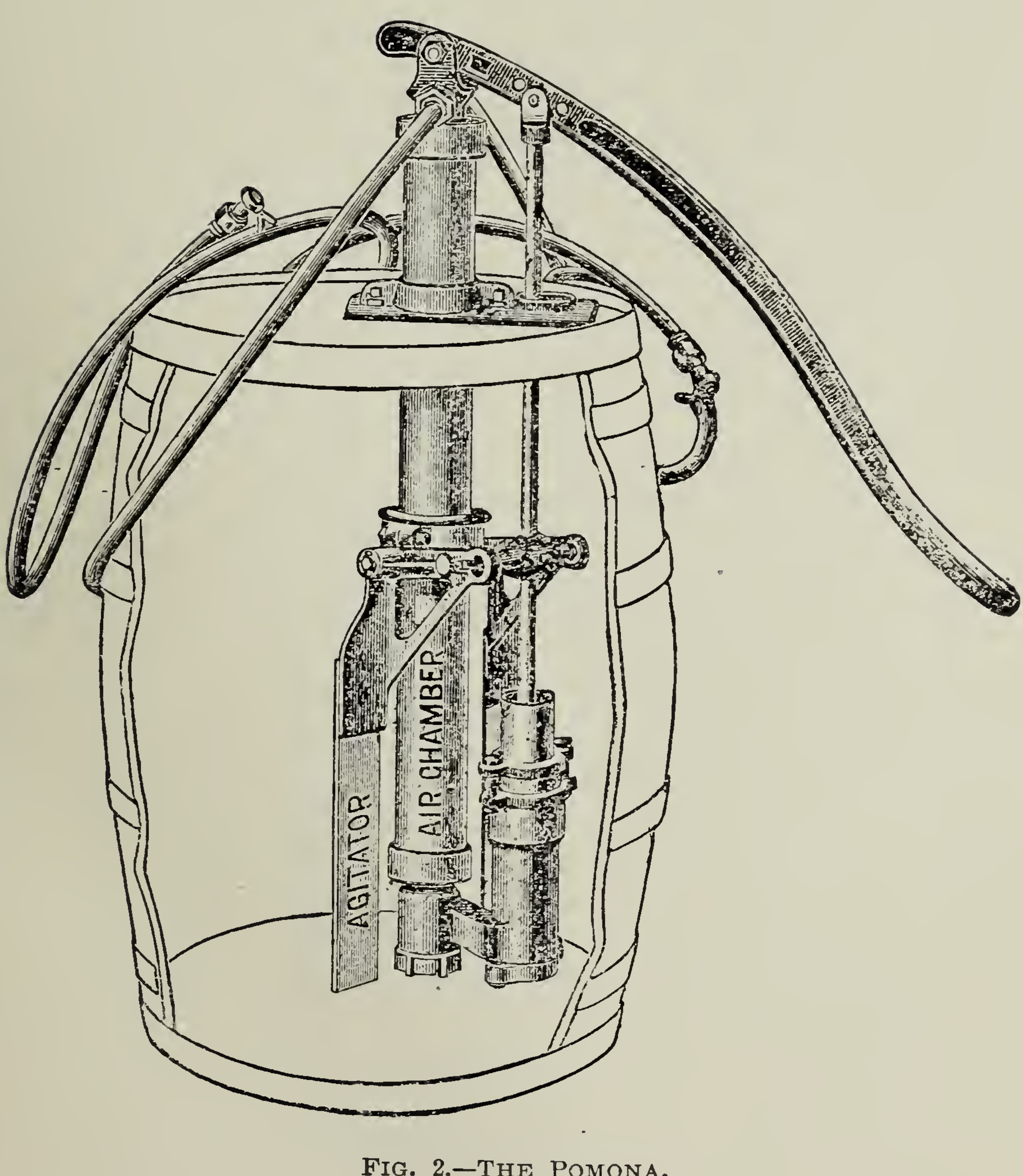


FIG. 2.—THE POMONA.

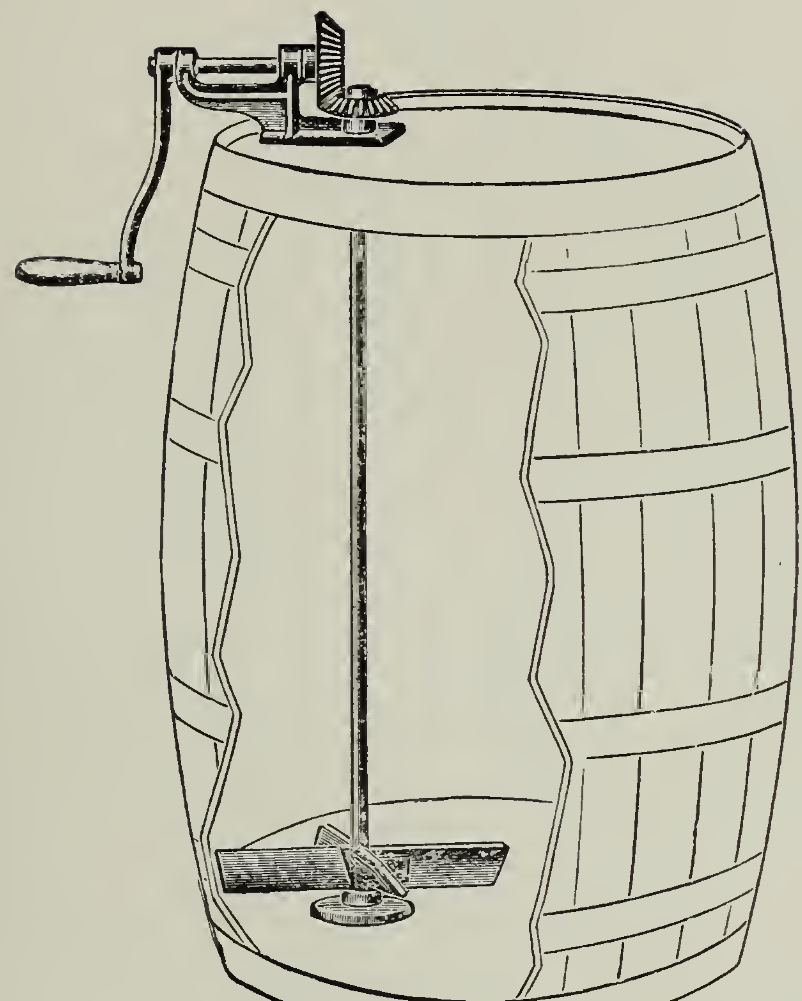


Fig. 3.—An Agitator.

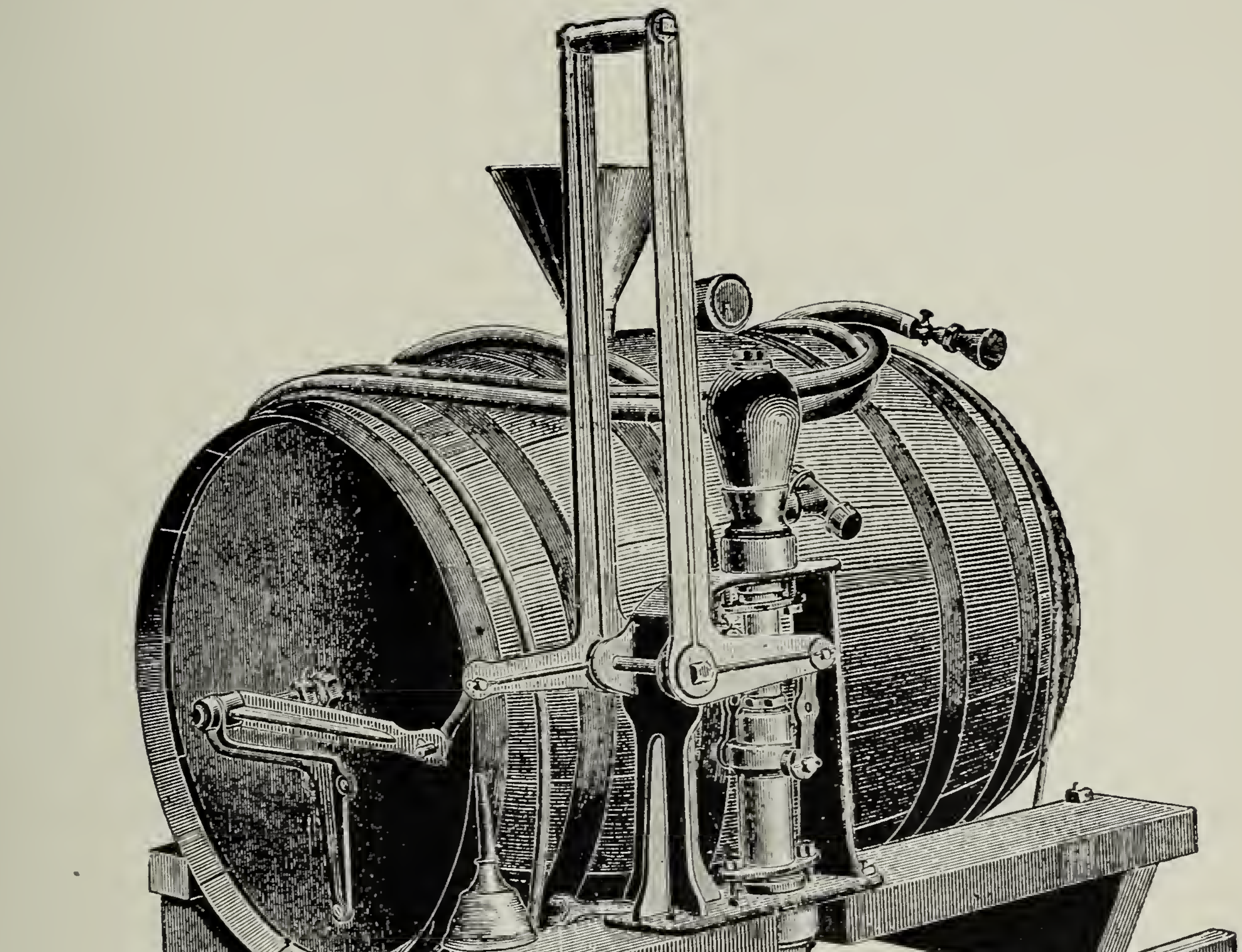


Fig. 4.—The Caswell Pump, No. 2.

on the outside of the barrel; this is quite different from the old way of loosening four or more rusty bolts that can be reached only through a small hole in the top of the barrel.

The Pomona.—The Pomona pump, illustrated in Figure 2, is manufactured by the Gould Pump Company, Seneca Falls, N. Y. It is listed at $20. It is much like the Eclipse in its construction, but a change has been made for the better in the plunger and cylinder. Instead of the long cylinder and short plunger, with packing on the latter, a comparatively short cylinder provided with a stuffing-box is used, while a long brass plunger passes entirely through the cylinder with each stroke of the handle. With this arrangement one part of the cylinder cannot wear more than another.

Two styles of agitators are furnished with this pump. One is worked by the pump handle as shown in the cut. The other style is illustrated in Figure 3, which explains itself. Either one does good work, but the liquid may be more thoroughly stirred by the latter.

The Caswell.—Figure 4 illustrates the Caswell pump, manufactured by the Caswell Pump Company, Sandusky, Ohio. The list price is $20. These pumps have been thoroughly tested and have proven to be satisfactory. One of the largest fruit growing firms in this vicinity has used the Caswell for several years and is enthusiastic in its praise. All of the parts are made of brass, and are easy of access when any repairs become necessary. Either of the two valves may be gotten at by unscrewing a cap. This feature is quite an improvement over the old way of having to take the pump out of the barrel and all to pieces before any of the working parts can be reached. The plunger has an up and down motion, but the arrangement of the handle is such that it is similar in motion to that of a horizontal pump. Thus the weight of the body may be thrown on both the forward and backward strokes. The pump cannot be put on a barrel, but is bolted to the wagon frame, or to a frame made for the purpose, as shown in the cut. The agitator is not as good as could be desired, and when a larger tank is to be used some other form must be devised.

The Advance.—The Advance pump, illustrated in Figure 5, is manufactured by the Deming Pump Company, Salem, Ohio. The list price is $18.

In appearance this pump is much like the ones that were first placed on the market. The similarity is principally in appearance, as many improvements have been made. By detaching the stuffing-box cap the plunger and the lower valve may be taken out of the cylinder. Accordingly the pump need not be taken from the barrel and nearly to pieces when any repairs becomes necessary. The large air chamber, together with the large cylinder, insures a steady spray. The agitator consists of two blades and a plunger that are operated by a connection with the pump handle, as shown in the cut.

The pump was received so late in the season that it was impossible to give it a thorough test. It is certainly well made and powerful, and no doubt will prove to be a satisfactory outfit.

The Empire Queen.—This pump is manufactured by the Field Force Pump Company, Lockport, N. Y. The list price is $9. This is one of the old style pumps that must needs be unbolted and taken from the barrel and pretty much to pieces when any repairs become necessary. Therefore, where a large amount of work is to be done and repairs necessarily become more or less frequent it is likely that the improved forms will be cheaper in the end. In smaller orchards the low price might make it more economical than the more expensive pumps, since the wear would be much lighter. It does good work while in repair.

The agitator, however, is not as efficient as could be desired, as it has an easy motion and does not agitate the liquid violently as is necessary in order to do the best work.

The Geiger.—This pump is manufactured by the Geiger Pump Company, Rochester, N. Y., and is listed at $20. It may be classed among the novelties in spraying machinery, and as such only severe testing will determine its value. It works on the principle of the semirotary pumps. All who have tried pumps of this class know that they are very satisfactory as long as the parts fit closely. There are no valves to get out of order; no

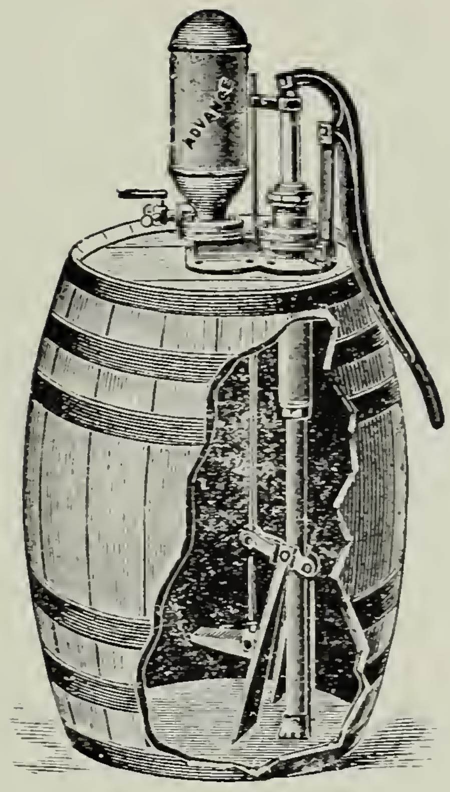


Fig. 5.—The Advance.

Fig. 6.—The Empire Queen.

FIG. 7.—THE GEIGER.

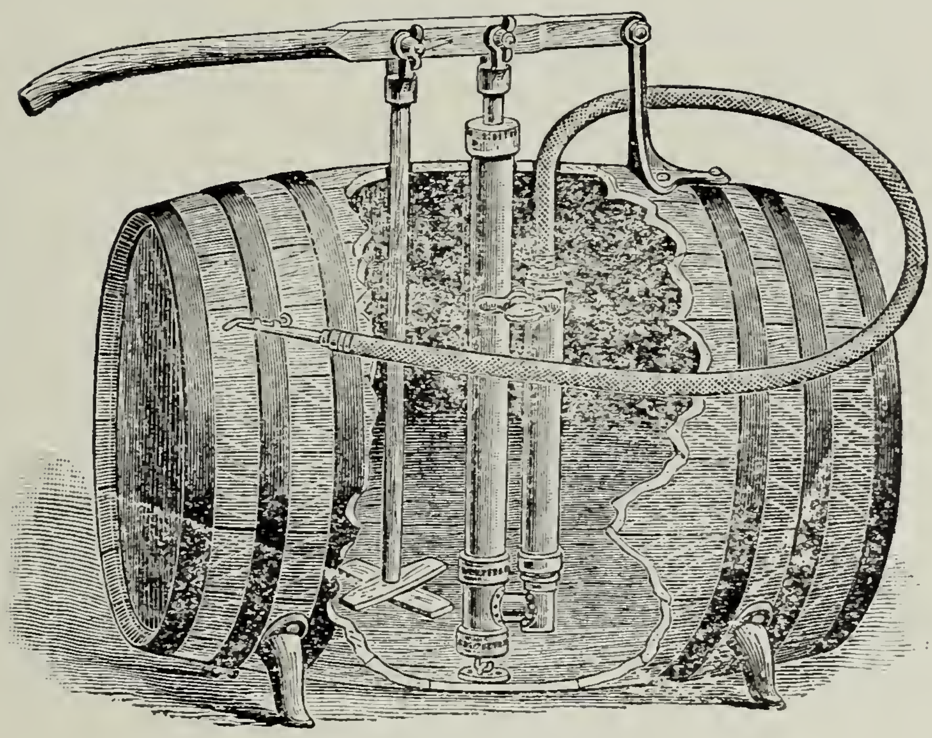


FIG. 8.—THE DEFENDER.

leather or rubber or packing of any form to be replaced; these points are of great importance. However it has been our experience that one season's hard use wears the cylinder so that it must be replaced.

The agitator of the Gieger is made to revolve by means of gearing and a crank, and consists of a blade or paddle fastened to a piece of tubing. The suction pipe is inside the tube and takes up the liquids through sieves in the blade of the agitator. As the pump was not received early enough in the season for us to give it a thorough test we are not able to speak positively as to its merits.

The Defender.—The P. C. Lewis Manufacturing Company, Catskill, N. Y., manufactures the Defender pump, which sells for $10. It is made to fasten on the side of a barrel, and is light and simple in its construction, as may be seen in the illustration. All parts that come in contract with the liquids are made of brass; the valves are made of leather but they are easily replaced when worn out, as the parts may be unscrewed with the hand. It is unfortunate that the hose couplings are of an unusual size, as the hose that is supplied with most pumps cannot be used interchangeably with this.

In spite of its small size the pump is quite powerful but it taxes its capacity to supply four nozzles. Its convenient form and light weight will commend it for many kinds of work, while its low cost brings it within the reach of all.

Bucket pumps.—These pumps are made to fasten on a pail, and are very useful where a small amount of spraying is to be done. They are manufactured in great variety and may be obtained from most dealers at a small cost.

Knapsack sprayers.—These machines are small spraying outfits that are designed to carry on the back, hence the name. There are several patterns manufactured by different firms, which differ from each other only in minor details. In general they consist of a copper tank, holding from three to five gallons, that is held in place on the back by straps over the shoulders. A small force pump is operated by one hand while the nozzle is directed by the other.

In a former bulletin these sprayers were recommended as being almost indispensable. With greater experience we find that so much hard, dirty work is involved in their use that we do not feel like recommending them except in cases where bucket and barrel pumps cannot be used to advantage.

Knapsacks may be obtained of most dealers in spraying supplies at a price ranging from $10 to $15.

Powder Guns.

Powder guns are used to apply poison and repellents for insects in the green-house or on small plantations of fruit or vegetables. The well-known Leggett Powder Gun may be taken as an example of these guns. It consists of a reservoir and an inclosed fan operated by a crank, which blows the powder out through a tube. It is supplied with a number of nozzles and tubes which are used in the different kinds of work. It is made principally of tin, and weighs about five pounds.

Some manufacturers assert that these guns are just the thing for poisoning bugs in large potato fields, using the clear Paris green. Most fungicides cannot be applied in a dry form, and since it is often advantageous to use both insecticides and fungicides it would seem to be better economy where a large amount of work is to be done to invest in a machine that will apply a remedy for both insects and diseases at the same time.

The Lightning Potato Bug Killer.— This little contrivance is quite convenient for applying poison and repellents for insects in the green-house or in small plantations of fruit or vegetables. It consists of a small hand bellows with a funnel-shaped spout. The material to be applied is poured into the bellows through the spout, through which it is puffed out in a cloud-like form. Where small amounts of tobacco dust, pyrethrum, hellebore or Paris green are to be applied this bellows will be very useful.

These implements may be obtained from dealers in florists' supplies at a small cost.

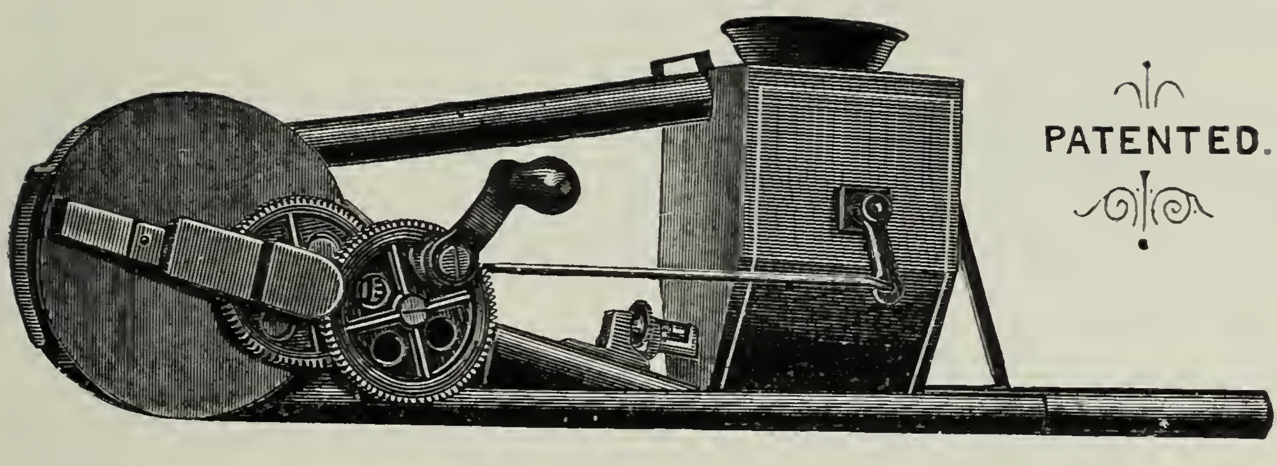


FIG. 9.—THE LEGGETT POWDER GUN.

FIG. 10.—STEAM SPRAYER.

POWER SPRAYING MACHINES.

Steam sprayers.— It is likely that in the near future some form of power spraying machines will be in common use on our large fruit farms. It is only about two years ago that steam was first used in spraying, so there has not been sufficient time to fully develop this form of spraying machinery. However, several firms are now manufacturing steam spraying outfits, and it is probable that great improvements will soon be made.

The Rochester Machine Tool Works, Rochester, N. Y., manufacture the power spraying machine illustrated in Figure 10. The outfit consists of a one-horse-power engine and boiler, a small steam pump and a spray tank. The entire outfit weighs about six hundred pounds, and may be loaded on an ordinary wagon.

The boiler burns kerosene, and will consume about three and one-half gallons in ten hours if run at full capacity. The pump is powerful, but since no air chamber is provided the spray is not as steady as could be desired.

The manufacturers appreciate the necessity of agitating the spraying mixture, and the engine is furnished for the purpose alone. It is to be hoped that some cheaper method of agitating may be devised. The manner of attaching the suction pipe to the bottom of the tank should be changed. No matter how perfect the agitation may be the particles of the mixture will settle in a pipe attached in this manner. Aside from the annoyance of clogging the nozzles, it not infrequently happens that the suction pipe becomes entirely stopped up. This cannot happen if the pipe enters the barrel from the top.

The list price of this outfit complete is $250.

Horse-power sprayers.— In spraying large areas of potatoes or truck crops where the machine may be kept in continuous motion, horse-power sprayers may be used to advantage. These machines may be divided into two classes, those that are provided with a pump, and those that discharge the liquid by force of gravity; of the two styles the former is much to be preferred.

since the liquid is forced through fine nozzles, and is, consequently, more intelligently applied. From four to six rows may be sprayed at a time, and where the machine is provided with a pump the nozzles can usually be adjusted so that they make satisfactory sprayers for vineyards that are located on level ground. Where the vineyard is planted on uneven or hilly land it is much more satisfactory to direct the nozzle by hand, even though a power machine is used.

Before buying, the purchaser should investigate the object thoroughly, so as to get a machine that is suited to his particular wants. The addresses of a few of the firms who are manufacturing horse-power sprayers are given below:

The Caswell Pump Company, Sandusky, O.; Thomas Peppler, Heightstown, N. J.; the Field Force Pump Company, Lockport, N. Y.; The Riverhead Agricultural Works, Riverhead, N. Y.

The machines manufactured by these firms, except the one last mentioned, were illustrated and described in Bulletin No. 74 of this Station. Copies of the bulletin may still be had upon application.

The mycologist of this Station, who is located on Long Island, sends the following description of the Hudson Sprayer, manufactured by the Riverhead Agricultural Works:

"The Hudson Spraying Machine is designed specially for applying Bordeaux mixture to potatoes, for which work it is well adapted. It sprays four rows at each passage. The parts are so arranged that each row receives the spray from two nozzles, which can readily be adjusted to suit the size of the plants. The machine is balanced, rider on or off, barrel full or empty. The capacity of the barrel is 45 gallons, and the liquid is drawn from the bottom. Thorough agitation of the liquid is effected by means of two diagonal paddles. The pipe carrying the nozzles is placed in front of the wheels, thus making it possible for the barrel to be filled by a man standing on the ground. The pump is a rotary one and supplied with a small air chamber. The 'shut off' and 'out gear' movements are made by one handle. With slight alterations the machine can be adapted to orchard

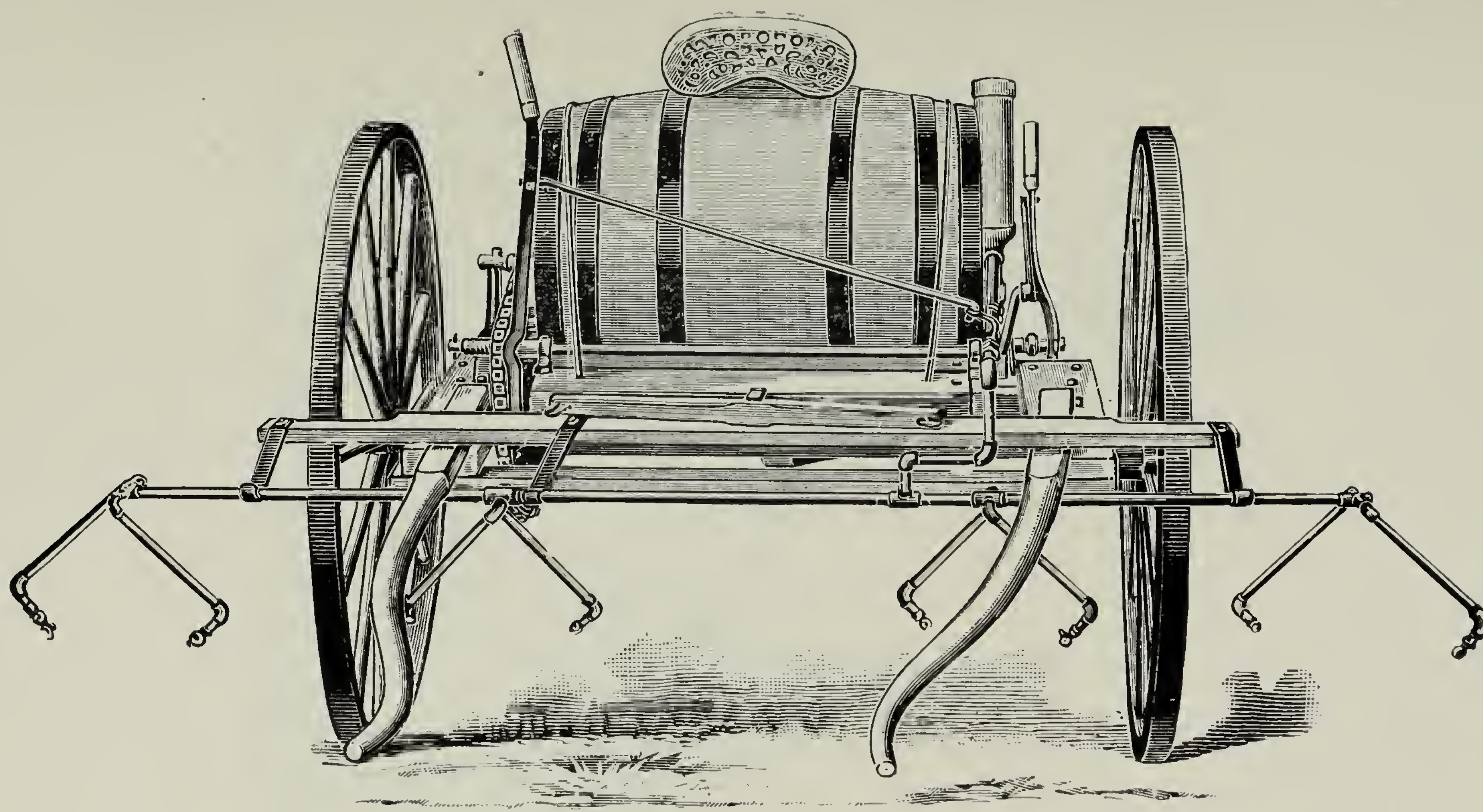


FIG. 11.—THE HUDSON SPRAYER.

Fig. 12.—A Home-made Outfit.

spraying. We have tested this machine through the whole of one season on seven acres of potatoes at Jamesport, L. I., and have found it quite satisfactory. It is manufactured by the Riverhead Agricultural Works, Riverhead, N. Y. Price, $75."

HOME MADE CONVENIENCES.

Spraying is hard, dirty work at best, and any machinery or method that will facilitate the work is eagerly sought. Many ideas for improvement that are adapted to the needs of different conditions will suggest themselves as the work progresses.

If in a large orchard a tank larger than a kerosene barrel is wanted it should be made of a round form so there will be no corners for the mixtures to settle in.

Where very tall trees are to be sprayed it may be advantageous to build a platform on the rear of the wagon for a man to stand on who is to spray the tops of the trees. The height of the platform will depend on the height of the trees to be sprayed. Fig. 12 shows such an outfit that was made here at the Experiment Station to be used in our orchards.

We have seen a very serviceable home made outfit for spraying potatoes. It consisted of a barrel pump mounted in a light one-horse wagon and by means of a hose and a few feet of gas pipe a simple arrangement was made to fasten to the rear of the wagon that extended out over four rows. By attaching nozzles at proper intervals to the pipe the four rows were sprayed as the wagon moved over them. With a boy to drive and a man to pump, a large amount of territory may be gotten over in a day with such an oufit. The same pump will of course serve to spray trees as well. By the exercise of ingenuity the necessity of buying expensive apparatus may often times be avoided and the home-made tools may be even more serviceable as they are made to suit the conditions that exist on our own farms.

SUNDRY NOTES.

Nozzles.—In order to do the best work a nozzle should throw a fine mist-like spray that will float in the air and slowly settle. With such a spray nearly all of the leaf surface may be thinly

coated with the minute particles and yet be almost unnoticed by the casual observer.

The best work cannot be done with a nozzle that throws a coarse spray, or by drenching the trees till the particles collect in drops on the leaves and branches and fall to the ground.

Each season brings its array of new and modified forms of nozzles, but for our work we have yet to find any nozzle that is as satisfactory as the Vermorel, providing that it is of the right pattern. Various forms are on the market, but those that have no joint between the nozzle chamber and elbow, are a source of annoyance, as the best of them sometimes become clogged in the elbow, and where there is no joint it is next to impossible to reach the obstruction. Vermorels that are not open to objection are illustrated in Figures 13 and 14.

The Vermorel produces a very fine mist-like spray, which it can throw but a very few feet beyond its orifice. Therefore where very tall trees are to be sprayed it may be necessary to use a nozzle that will throw a spray to a greater distance. The McGowen nozzle is quite satisfactory for such work. In any case it will be seen that where trees are to be sprayed the Vermorel nozzle must be lifted up among the branches. The bamboo extension was devised for this purpose.

Double discharge nozzles.— For most spraying it is most advantageous to use more than one nozzle on a single line of hose, as the work can be done much quicker than when only one nozzle is used. Various forms of connections are manufactured for this purpose. Triple connections are also used where it is desired to use three nozzles on the same hose.

Bamboo extension.—This consists of a three-eighths inch brass tube inside of a bamboo pole. At the lower end of the tube is a stop-cock and hose connection, while the nozzle is attached to the upper end. Several other methods of elevating the nozzle are used, such as the use of small iron or galvanized pipe, but this form is mentioned in particular for the reason that it is light and convenient to handle. Extensions may be made of any convenient length.

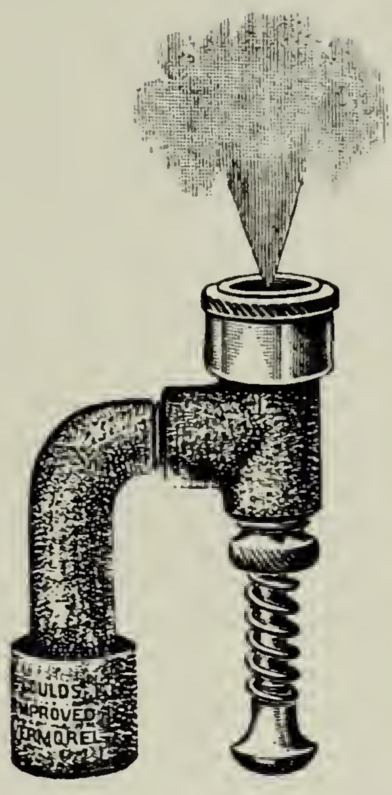


FIG. 13.—VERMOREL NOZZLE.

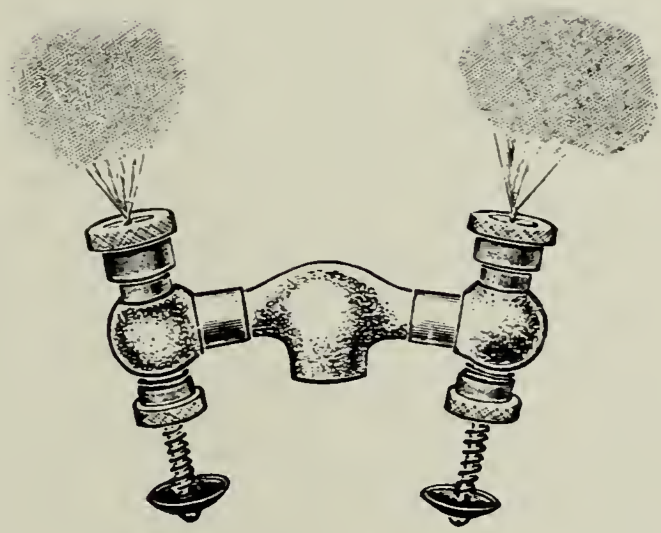


FIG. 14.—DOUBLE VERMOREL.

Bordeaux mixture.—There are several different formulas for making Bordeaux mixture, any one of which will no doubt give excellent results if the directions are closely followed. The formula given below has been used at this Station for the past five years, and it is also generally used by the fruit growers of this vicinity. In no case has it proven unreliable, so we do not hesitate to recommend it as being one of the best and certainly the quickest method by which Bordeaux mixture can be made. Much has been written of late for and against the practice of using the potassium ferrocyanide test for determining the amount of lime to be used, and many nice points have been brought forth as to just how this test should be applied. We still adhere to the common method of applying it, as we have always found it reliable:

Formula.—	Copper sulphate	4 lbs.
	Lime	3 lbs.
	Water	45 gals.

Dissolve the copper sulphate in hot water or by suspending in a coarse cloth or bag in a considerable amount of cold water, so that the sulphate is just covered. It will not all dissolve if placed in the bottom of a vessel of cold water. When dissolved dilute the solution to two-thirds of the required amount. Next slake the lime and add it to the solution in the form of a thin whitewash—the thinner the better. Strain it if necessary to keep out particles that would clog the nozzle. The mixture should be thoroughly stirred while the lime is being added. It is essential that the copper solution should be quite dilute before the lime is added, otherwise a heavy precipitate is formed.

Weighing the lime.—It is easy to see that the weighing and slaking of the required amount of lime each time a barrel full of the mixture is to be made will require a considerable amount of time in the course of a day, which at this busy season is quite an item. By using the color test the necessity of weighing the lime is done away with and enough lime may be slaked at one time to last through the season. A convenient way to keep the lime is to slake it in a barrel that is partially sunk in the ground,

as is shown in Figure 15. When treated in this manner it will keep indefinitely in the form of paste if the surface is kept covered with a small amount of water. It will be economy to buy a good quantity of fresh lime. Air slaked lime is worthless.

Potassium ferrocyanide test.—Fill the spray tank two-thirds full with the copper sulphate solution, then pour in the milk of lime. Stir the mixture thoroughly and add a drop of the potassium ferrocyanide. If enough lime has been added the drop will not change color when it strikes the mixture, otherwise it will immediately change to a dark reddish brown color. More lime must then be added until the ferrocyanide does not produce the reddish brown color. Even after the test shows no color more lime should be added so as to be sure that all of the copper will be precipitated, for in case the mixture has not been thoroughly stirred some of the copper may still remain in solution in the bottom of the barrel while the test shows no color at the surface.

An excess of lime will do no harm, while the free copper solution will injure the foliage.

The potassium ferrocyanide, or yellow prussiate of potash, is a poisonous yellow salt which readily dissolves in water. A few cents worth dissolved in about ten times its volume of water will last through the season.

Stock solution of copper sulphate.—Where a good deal of spraying is to be done it will be found advantageous to make up a stock solution of copper sulphate. This may be made by dissolving any number of pounds of the sulphate in one-half as many gallons of water. A gallon of the solution will contain two pounds of the sulphate, therefore two gallons will contain the required amount for a barrel of Bordeaux mixture. Suspend the sulphate in the top of the water, otherwise it will not all dissolve if the water is cold. The stock solution must be kept well covered in order to prevent evaporation.

Saturated solution of copper sulphate.—An up-to-date orchardist recently suggested that a saturated solution of copper sulphate

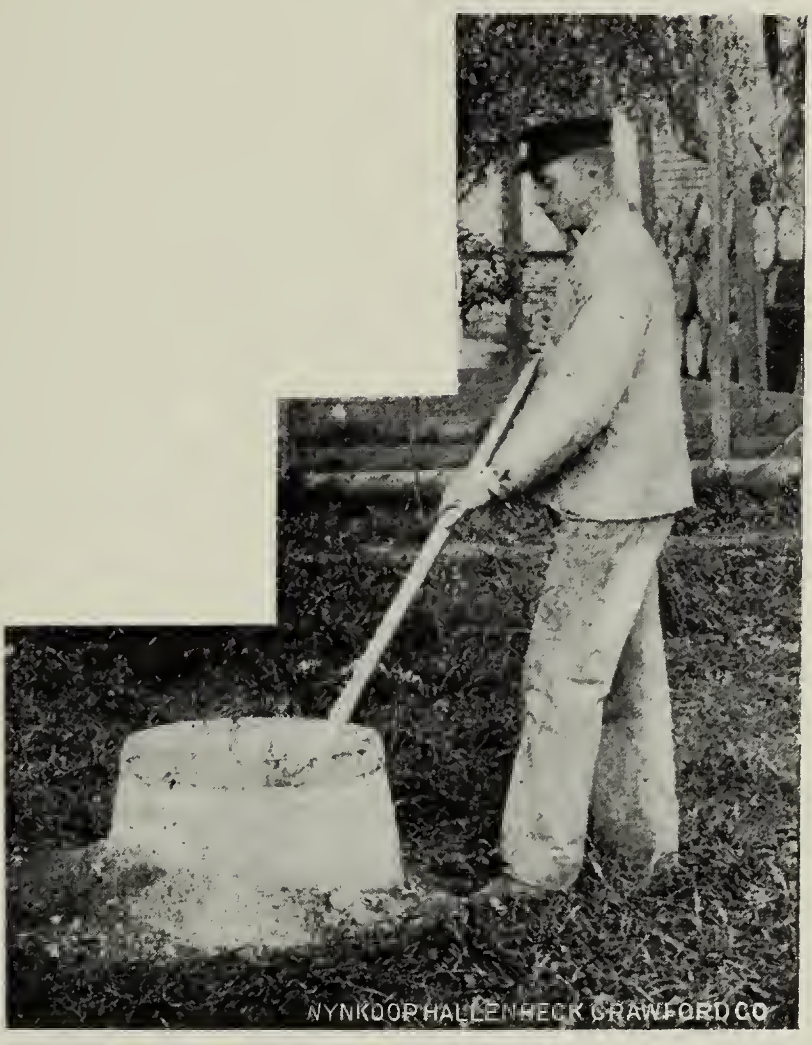


FIG. 15.—METHOD OF KEEPING LIME PASTE.

would be more convenient than the ordinary stock solution as there would be no necessity of weighing the copper sulphate or of measuring the water. This gentleman has followed this plan for two seasons with good results. However this method can only be commended to careful men who will take pains to see that the solution is always a saturated one. A large vessel of cold water is provided in which is suspended a large amount of copper sulphate, more than the water can possibly take up. This should be prepared at least a day before the solution is wanted for use in order that the sulphate may have time to dissolve. As the solution is taken out more water should be added to the vessel from time to time and copper sulphate should be constantly kept in suspension. By exercising a due amount of care a fairly even solution may be maintained. One gallon of water at ordinary temperature, 59° F., will dissolve 49 ounces of copper sulphate. Therefore one and one-third gallons of such a solution will contain the required four pounds of copper sulphate for a barrel of Bordeaux mixture.

Bordeaux mixture should be used soon after it is made, or at least on the same day that it is made, as it soon begins to deteriorate in value.

Kerosene emulsion.—Kerosene emulsion is made by dissolving one-half pound of common soap or whale oil soap in one gallon of soft water. Heat the mixture, and when boiling hot remove it from near the fire and add it to two gallons of kerosene. The whole is now thoroughly mixed by pumping continuously through a small force pump for about five minutes. Mix until the ingredients form a creamy mass that becomes thick when cool and from which the oil does not separate. When using on foliage dilute with from ten to fifteen parts of water; when used as a winter treatment it may be applied as strong as one part of the mixture to four parts of water. After the stock emulsion becomes cold it hardens so that it is necessary to melt it before it can be successfully diluted. It takes fire very readily, so it is always a safe plan to have a fire out of doors when making the emulsion. This emulsion is used to kill insects that have sucking mouth parts; it is not a poison but kills by contact.

When applying the mixture with pumps that have rubber balls for valves, it must not be forgotten to replace the balls with marbles as the kerosene soon destroys rubber. There is a large amount of whale oil soap of poor quality on the market which accounts for trouble that some people experience in forming the emulsion. Only the better grades of whale oil soap should be used.

Paris green.—Paris green is used to poison insects that have biting mouth parts. It may be applied either in the dry form or in a spray. When the spray is used the Paris green may be combined with Bordeaux mixture, or it may be applied mixed with water. In either cases the same amount of poison is used. For pomaceous fruits, such as apple and pears, one pound of Paris green to one hundred and fifty or two hundred gallons is commonly used. For stone fruits the mixture should be weaker, using one pound of Paris green to two hundred and fifty or three hundred gallons. When used with water, two pounds of fresh slaked lime must be added for each pound of Paris green, to prevent injury to the foliage.

The adulteration of Paris green has come to be a great source of annoyance and loss to the farmer and fruit grower. There should be but one grade of Paris green and that the pure article, yet many dealers have different grades for sale. The cheaper goods must necessarily be adulterated. Where adulteration is suspected, if some of the poison is crushed between two pieces of window glass or between the thumb and finger, oftentimes the small lumps will be found to be white inside, showing that some adulterant has been used. The ammonia test which is very simple though not infallible may also be used. Pure Paris green will readily dissolve in ammonia and the solution will be of a deep blue color. If there is any residue, or if the solution does not become blue at once, adulteration may be suspected.

PLATE I.—RASPBERRY CANES ATTACKED BY ANTHRACNOSE. FROM DRAWING BY W. P. WHEELER.

III. ANTHRACNOSE OF THE BLACK RASPBERRY.*

WENDELL PADDOCK.

SUMMARY.

The following pages give an account of experiments in combating anthracnose of the black raspberry, which were continued through three successive years. While the treatment was successful in preventing the spread of the disease to the new canes, in no instance did the sprayed rows yield enough more fruit to make the spraying a paying operation. Each person must decide from the conditions existing in his own plantation whether or not it will pay to spray for this disease.

In localities where anthracnose has been sufficiently virulent to warrant treatment the following measures are suggested.

(1) Use only healthy plants and adopt a short rotation of crops.

(2) Protect the new shoots in the spring by spraying them with Bordeaux mixture when they are about six inches high; or better still, spray for the first time when the first few scab spots appear on the young canes. Follow the first spraying with two others, or more if it seems best, at intervals of about ten to fourteen days. Remove all old canes and badly diseased new ones as soon as the fruiting season is over.

INTRODUCTION.

The growing of most of our fruits of commercial importance is attended with more or less difficulty because of the attack of plant diseases and injurious insects. In this respect the raspberry is no exception, but it is less liable to such attacks than are many fruits.

*Reprint of Bulletin No. 124.

There are only a few diseases that are widely distributed in the raspberry plantations of New York. Of this number, orange rust and anthracnose are particulary troublesome. Orange rust is easily recognized by the bright orange color that its masses of spores give to the underside of the leaves or other growing parts of the plant on which they chance to form. Anthracnose, however, is not so easily recognized and so is all the more dangerous. Great confusion exists in regard to the appearance of this disease and its effect on the plant, so a somewhat extended popular description is given.

What are plant diseases?—In order that we may more readily grasp the discussion let us consider briefly the nature of plant diseases. The fungi that cause plant diseases are minute plants of low order that live as parasites on higher plants. It requires the assistance of a powerful microscope to make out the characters of most of these tiny plants, yet they are just as truly plants as are the trees upon which some of them live. They have organs called mycelium that correspond to roots and modified branches of the mycelium bear minute bodies called spores, that are similar to and perform the same office as seeds. Under favorable conditions of moisture and temperature the spores are borne in innumerable quantities and they readily germinate under the same conditions. The spores are very small and light so are borne on the slightest breath of air. Scattered by the winds or other agencies the disease spreads rapidly when the weather conditions are suitable.

What is anthracnose?—The name anthracnose is a popular term that has come to be applied to plant diseases that are caused by one of the two groups of fungi known as Colletotrichum or Glœosporium. The anthracnose of the raspberry belongs to the Glœosporium group. The different species of this genus attack their host plants differently. The one that lives on raspberries may attack any part of the plant but is more commonly found on the canes and it spreads principally by attacking the young shoots. The fungus remains dormant during the winter on the canes but as soon as suitable weather comes in the spring, spores

are formed on the diseased areas and infection begins. It makes its first appearance on the young canes oftentimes when they are from six to ten inches high and at any point on them where the spores may chance to fall. It is supposed that the germ tube of the spores can enter only young and tender tissue, consequently the spread of the disease is toward the tip of the cane naturally following the tender growing part. Therefore we find the small spots toward the top, while the larger, older ones are lower down on the cane. The disease first appears on the new canes as small, dark or purple colored spots, few at first but increasing rapidly in number providing a diseased spot on an old cane is in close proximity and the weather conditions are favorable for the production and germination of spores. The new spots rapidly increase in size, changing from the dark color to a brown or dirty white in the center as the fungus feeds outward in all directions and leaves the dead tissues behind. The slightly raised outlines of the spot vary in color from dark-brown to bright purple. As the cane grows older it throws out numerous layers of corky tissue around the diseased spots in its effort to heal the wounds, thus giving the diseased canes a rough, scabby appearance. If badly infected the spots are so numerous on the cane that they soon grow into one another and form large blotches or scabs sometimes six or eight inches long, often entirely encircling the cane and thus effectually girdling it.

This minute plant lives on the juices contained in the cells of the tissue that lies just beneath the outer bark, the most vital part of the plant; here the threads of the mycelium cross and interlace and ramify in all directions absorbing nourishment that should go to build up the cane. As the disease advances it leaves the cells of the tissue discolored and collapsed. Where a scab spot nearly or entirely encircles a cane the supply of sap is cut off and the cane withers and dies. It is not known that the fungus works into the wood but its attacks occasionally cause the canes to crack and expose the pith.

While the anthracnose of the raspberry may be said to be pre-eminently a disease of the canes, it sometimes attacks the leaves,

where it produces small brown spots. The curling and browning of the leaves is often caused by anthracnose but it is usually the result of a diminished sap supply, caused by the attacks of the disease on the canes below rather than by a direct attack on the leaves. The disease also frequently attacks the leaf stems and small fruiting branches where it appears as small, dark or grayish patches on the bark the same as on the canes. If the attack is severe the leaves may wither and die and the fruit dry up on the bushes.

Where a plantation is badly diseased the casual observer may not notice that there is anything wrong with the plants the first two years from setting. In the third year when they should bear their largest crop of fruit the plants may still look fairly well, the new canes make a moderate growth and the fruiting stems give promise of a good yield of fruit, but before the berries have a chance to ripen they shrivel and dry on the stems and the foliage assumes an unhealthy color. If the plants are not removed, the next spring the foliage is scant and pale, and before midsummer the leaves become shriveled and dry and many of the plants die.

Fortunately, however, it is not often that anthracnose is so disastrous in its effects. In many localities it remains about the same from year to year without killing the plants or causing the fruit to dry up on the bushes. Yet the unsuspecting grower complains that his crops are not what they used to be. The plants, enfeebled by the disease, are more liable to winter-injury; and the constant drain on their vitality tends in many ways to lessen the fruit production. Then, again, traces of anthracnose may be found in a great many plantations where it has never spread enough to do any appreciable amount of injury.

The disease is more prevalent in some locations than in others, and some varieties of berries are more susceptible to its attacks than are others. While anthracnose is more severe on black raspberry it does not confine its attacks to this species but occurs on the other species that are commonly cultivated as well as on the blackberry.

EXPERIMENTS IN TREATING THE DISEASE AT CLIFTON.

In the spring of 1894, a communication was received from Mr. S. A. Hosmer, of Clifton, N. Y., in regard to anthracnose on raspberries. He kindly offered the Station the remains of his once large plantation to use in experimenting with treatment for the disease.

The plantation at one time consisted of 25 acres and was regarded as producing one of the most paying crops of the farm; but through the ravages of anthracnose the acreage was yearly reduced until scarcely three acres of badly infested plants remained. Seemingly every cane was diseased, immense scabs and blotches from four to eight inches in length and reaching nearly or quite around the cane being not uncommon. This plantation, consisting entirely of Gregg, was set out in the spring of 1890. There were 50 rows in the patch remaining which occupied about three acres of land.

It would seem that here were ideal conditions for experimenting with methods of treatment for combating the disease. Accordingly experiments were planned which were carried on through three successive years.

Plan of the experiment.— Primarily, the experiment was undertaken to see if the disease could be successfully combated; secondly, different solutions were used for the first treatment, so that a comparison might be made as to their effectiveness in treating the disease.

Knowing that a remedy for any fungous disease must be a preventive rather than a cure, and that many fungi begin their work very early in the spring, it was planned to give the first treatment before the leaf buds opened; at this time strong solutions could be used as there would be no foliage to be injured; accordingly the rows were treated as shown in the accompanying table:

The first three rows were sprayed with copper sulphate solution, using three pounds to eleven gallons of water. The next three with a saturated solution of iron sulphate in water, while the next three were left unsprayed for comparison. This plan was carried on throughout the plantation until the last two rows

TABLE I.—TREATMENTS APPLIED TO RASPBERRIES FOR PREVENTION OF ANTHRACNOSE.

Apr. 18, sprayed with copper sulphate solution. May 1, sprayed with Bordeaux mixture. May 16, do. May 30, do. June 21, do. Aug. 9, do.	Apr. 18, sprayed with iron sulphate solution. May 1, sprayed with Bordeaux mixture. May 16, do. May 30, do. June 21, do. Aug. 9, do.	Unsprayed.	Apr. 18, sprayed with acid copper solution. May 1, sprayed with Bordeaux mixture. May 16, do. May 30, do. June 21, do. Aug. 9, do.	Apr. 18, sprayed with acid solution. May 1, sprayed with Bordeaux mixture. May 16, do. May 30, do. June 21, do. Aug. 9, do.
Rows. 1, 2, 3 10, 11, 12 19, 20, 21 28, 29, 30 37, 38, 39 46, 47, 48	Rows. 4, 5, 6 13, 14, 15 22, 23, 24 31, 32, 33 40, 41, 42	Rows. 7, 8, 9 16, 17, 18 25, 26, 27 34, 35, 36 43, 44, 45	Row. 49	Row. 50

were reached, making in all 18 rows treated with copper sulphate, 15 rows treated with iron sulphate and 15 untreated or check rows; of the last two rows one was sprayed with a solution made up of ten parts of a saturated solution of copper sulphate to one part of sulphuric acid, and the other with a 10 per cent solution of sulphuric acid. After the first treatment all treated rows were sprayed alike with Bordeaux mixture using one pound of copper sulphate to make eleven gallons of the mixture.

EXPERIMENTS IN 1894.

Dates of spraying.— The first spraying was made April 18, just as the leaf buds were beginning to swell. All of the different mixtures were applied on the same day. That evening a heavy rain set in which lasted three days.

The second spraying was given May 1, when the leaves were about one-fourth grown. At this time it was noticed that there were numerous small dark spots on the canes in the rows that had been sprayed with the sulphuric acid solution, which indicated that the acid had been applied too strong. The heavy rain that came on just as the work was finished undoubtedly washed off a good deal of the acid and thus saved the plants from serious injury.

The next treatment was made May 16. The leaves were nearly full grown, while the largest of the new canes were about eight inches in height. The work of the fungus on the new canes was now noticed for the first time; a few of the small characteristic spots were seen on the new shoots where they grew close to a diseased spot on an old cane. Immediately after this spraying was given the severe spring rains set in which lasted intermittently for 21 days.

On May 30, a fourth spraying was given. It was noticed at this time that the previous spraying had seriously injured both the fruit and foliage. On looking about for a cause for the injury it was found that the capacity of the measure that was used in making the Bordeaux mixture had been mistaken, consequently the mixture was made much stronger than was intended. The injury was probably due to this fact as raspberries on the Station plats that were sprayed throughout the season with Bordeaux mixture, using one pound of copper sulphate to make eleven gallons of the mixture, were not injured. Raspberry foliage was not found to be particularly liable to injury from Bordeaux mixture at this strength. However, as the new canes are the only parts of the plants that need protection, the spray should be directed toward them alone.

A fifth treatment was given on June 21. The difference in the amount of disease on the treated and untreated rows was very noticeable at this time. Nearly every fruiting stem and new cane on the unsprayed plants was attacked by anthracnose while in the sprayed rows the appearance of the disease was much less noticeable.

After the fruiting season was over the old canes were removed and burned, when the last spraying for the season was given on August 9.

The plantation was visited on November 22, when the plants of both the sprayed and unsprayed rows were found to have made a vigorous growth. The canes in the treated rows were nearly free from disease while those that were not sprayed were still badly affected.

The yields of the different rows are given below in Table II.

TABLE II.—YIELD OF RASPBERRIES DIFFERENTLY SPRAYED DURING THE SEASON OF 1894.

DATES OF PICKING.	Sprayed once before leaf buds opened with copper sulphate solution followed by five sprayings with Bordeaux mixture. 18 rows.	Sprayed once before leaf buds opened with iron sulphate solution followed by five sprayings with Bordeaux mixture. 15 rows.	Unsprayed. 15 rows.
	Quarts.	Quarts.	Quarts.
July 13	....	....	109
July 16	158	137	225
July 18	41	52	99
July 20	57	67	83
July 23	109	99	75
July 25	33	47	27
Total	398	402	618
Average per row	22	26 4-5	41

The record of yields tends to prove nothing except that the treatment seriously injured the fruiting canes in the treated rows. It should be borne in mind, however, that this injury was due to the fact that the Bordeaux mixture used in a single application was improperly made. The almost entire absence of anthracnose on the treated rows as compared to the considerable amount found on the unsprayed rows at the close of the season goes to show that the treatment was effective.

EXPERIMENTS IN 1895.

The plantation was given the same treatment throughout the season of 1895.

Dates of spraying.—The first spraying, when the diflerent solutions were applied, was given on April 26, just as the leaf buds began to swell. The second treatment was begun May 11, but on account of rain it was not completed until May 13. At this time the new canes had just begun to grow. On May 24, a third spraying was given, when the largest of the new canes were twelve to fourteen inches high. At this time it was noticed that the two rows that had been sprayed with the sulphuric acid solutions had been seriously injured by the application. A fourth

treatment was given on June 10. A few of the characteristic spots of anthracnose were now noticed for the first time on the new canes in the untreated rows, showing that the disease was spreading very slowly. June 24 a fifth treatment was made. It was again noted that the disease had spread but little on the unsprayed plants and practically none could be found on the treated canes. As soon as the fruiting season was over the old canes were removed from all the rows, and a sixth spraying was given August 15.

The yield for the season of 1895 is given below in Table III.

TABLE III.— YIELD OF RASPBERRIES DIFFERENTLY SPRAYED DURING THE SEASON OF 1895.

DATES OF PICKING.	Sprayed once before leaf buds opened with copper sulphate solution followed by five sprayings with Bordeaux mixture. 18 rows.	Sprayed once before leaf buds opened with iron sulphate solution followed by five sprayings with Bordeaux mixture. 15 rows.	Unsprayed. 15 rows.
	Quarts.	Quarts.	Quarts.
July 5	177	184	154
July 8	210	293	218
July 10	181	87	111
July 12	201	177	159
July 15	204	175	31
July 17	66	52	148
July 19	38	29	38
Total.	1,077	997	859
Average per row	59 5-6	66	57

Again the record of yields fails to show any material gain resulting from the treatment. The cause of the slight increase in yield of the rows that were sprayed once before the leaf buds opened with iron sulphate would be difficult to explain.

The plantation was visited on Nov. 19, when it was found that the canes in all of the rows that had been sprayed were practically free from disease, and since the removal of the old canes in August but comparatively little was to be found on the unsprayed rows.

EXPERIMENTS IN 1896.

Although the plantation had passed the age of greatest fruitfulness, the owner decided to keep it another season, and so it was determined to continue the experiment, hoping that ideal conditions, from the experimenter's standpoint, might arise when the yields of fruit from the treated and untreated rows would show marked results in favor of the treatment.

Dates of spraying.—The first spraying, with the strong solutions, was given the plants on April 22, when the leaf buds were swelling. The second spraying was given on May 9. The third on May 25 and the fourth on June 8. On the latter date, a few of the scab spots were noticed the first time on the young canes. The new canes were now practically out of danger from attacks of the disease because of their size and the scarcity of the scab spots on the old canes, therefore the treatment was discontinued.

The yields of the different rows for the season of 1896 are given in Table IV.

TABLE IV.—YIELDS OF RASPBERRIES DIFFERENTLY SPRAYED DURING THE SEASON OF 1896.

DATES OF PICKINGS.*	Sprayed once before leaf buds opened with copper sulphate solution followed by three sprayings with Bordeaux mixture. 18 rows.	Sprayed once before leaf buds opened with iron sulphate solution, followed by three sprayings with Bordeaux mixture. 15 rows.	Unsprayed. 15 rows.
	Quarts.	Quarts.	Quarts.
	40	51	52
	155	181	174
	131	130	142
	156	164	135
	188	196	170
	69	101	88
	103	80	70
Total	842	903	831
Average per row	47	60	55

* As the pickings were not made under Station direction the dates can not be given for this year.

The results show no gain resulting from the treatment. The yield of the rows sprayed once before the leaf buds opened with

copper sulphate solution falls below that of the unsprayed rows; while the rows that were sprayed with iron sulphate gave a little larger yield than the check rows.

EXPERIMENTS AT MANCHESTER.

In the spring of 1896 a letter was received at the Station from Mr. Luther Rice, Manchester, N. Y., in which he made inquiries about treatment for raspberry anthracnose. Mr. Rice is an extensive grower of raspberries, and at times has found anthracnose to be a serious pest. On visiting his place it was found that a small plantation of one variety, consisting of thirteen rows, about twenty rods long, was badly diseased. The plantation was two years old, so it would seem that here were favorable conditions for continuing the spraying experiments.

Plan of the experiment.—From our previous experience we had come to doubt the advisability of giving the early spraying with strong solutions. Therefore, in this experiment it was planned to compare the early with the late treatment, at the same time using the copper and iron solutions for the early treatment as before. It became evident that spraying with sulphuric acid solutions is too heroic a measure to be used on raspberries, therefore this line of treatment was dropped.

TABLE V. — TREATMENT APPLIED TO RASPBERRIES AT MANCHESTER FOR PREVENTION OF ANTHRACNOSE.

Apr. 18, sprayed with copper sulphate solution. May 2, sprayed with Bordeaux mixture. May 12, do. June 3, do.	Apr. 18, sprayed with iron sulphate solution. May 2, sprayed with Bordeaux mixture. May 12, do. June 3, do.	May 12, sprayed with Bordeaux mixture. June 3, do.	Unsprayed.	May 2, sprayed with Bordeaux mixture. May 12, do. June 3, do.
Rows. 1, 5, 9	Rows. 2, 6, 10	Rows. 3, 7, 11	Rows. 4, 8, 12	Row. 13

The rows, Nos. 1, 5, and 9 were sprayed once before the leaf buds opened, with copper sulphate solution, using three pounds of the sulphate to eleven gallons of water. Rows No. 2, 6 and 10 were sprayed once before the leaf buds opened, with a saturated solution of iron sulphate. Rows No. 3, 7 and 11 were sprayed for the first time when the rows that were sprayed with the strong solution received the third treatment. Row No. 13 was sprayed for the first time when the rows that were sprayed with the strong solutions received their second treatment.

Dates of spraying.—The first spraying, when the strong solutions were used, was given on April 18, when the leaf buds were beginning to swell. In the subsequent treatments Bordeaux mixture was used on all of the treated rows. The second spraying was given on May 2, when the canes were in nearly full leaf. Row 13 was sprayed for the first time on this date. All of the treated rows were sprayed on May 12, when some of the largest of the new canes were about two feet high. Rows 3, 7 and 11 were sprayed for the first time on this date. The last spraying for the season was given on June 3.

Record of yields.—The record of yields for the season was not complete, but it did not indicate that there was any increase in yield on the rows that were sprayed. Neither did any of the rows that received the different lines of treatment show any increase in yield over that of their neighbors.

The plantation was visited on Dec. 12, when it was found that the difference in the amount of disease on the sprayed and unsprayed rows was quite marked. All of the rows that had been sprayed were comparatively free from disease, while the unsprayed rows were still quite badly affected. The results were sufficiently marked so that it is deemed advisable to continue the experiment through another season.

CONCLUSIONS.

Ordinarily it will not pay to keep a plantation of black raspberries after it has produced its third crop. When such short rotations are followed, and the best of culture is given, it would seem that the danger from anthracnose must be reduced to a minimum, providing the plants are free from disease when planted.

In some instances, however, where raspberries are grown as a farm crop it will pay to fruit the plantation longer. Although the plants have passed the period of greatest fruitfulness, it may be that for a few seasons longer they will produce crops of fruit that will pay better than any other crop the grower might be able to put in their place.

If anthracnose makes its appearance, the old canes should be removed and burned immediately after the fruiting season is over. If in the following spring the new canes are protected with Bordeaux mixture, it is possible practically to free the plantation from the disease. While the results obtained from these experiments show conclusively that anthracnose of the black raspberry can be successfully combated with Bordeaux mixture, in no instance did the spraying prove profitable, and because of this fact the question at once arises as to whether or not it will pay to spray for this disease. In dealing with any plant disease that does not do serious damage every season, it will pay to spray in those instances only when there is danger of an attack that will be severe enough to endanger the life of the plants or materially injure the crop of fruit. Each grower must decide this point for himself.

The following letter from Mr. Hosmer gives his estimate of the treatment for raspberry anthracnose, which is based on the experiments that were conducted at his place:

"I am not cultivating raspberries so extensively as formerly, but if I had known then what I have since learned of the disease and the efficacy of the treatment you have employed in my plantation, it would have resulted in a saving to me of thousands of dollars. I had thirty acres of fine bushes almost completely ruined by the anthracnose in the midst of their prime.

"Yours truly,

"S. A. HOSMER."

When to spray.—No definite rule can be given as to the exact time when the spraying should be begun or how long it should be continued, since no two seasons will ever bring with them the same conditions. The experiments carried on at Manchester dur-

ing the season of 1896 go to show that the early treatment with strong solutions is unnecessary, as the rows that were sprayed for the first time after the new canes were several inches high were as free from disease as were the rows that received the early treatment. The treatment for any plant disease must be preventive, for we cannot cure the diseased spots that are already formed. All that spraying does is to prevent the formation of new disease spots by protecting the plants with some fungicide. Therefore, there is no need of beginning to spray much before the disease begins to spread. At no time during the three seasons through which our experiments have run did the scab spots begin to form on the new canes until after they were six inches high. However, it will require but very little attention on the part of the grower to determine when the disease becomes active, and at the first appearance of the small, dark-colored spots on the new canes the first spraying should be given. Let this treatment be followed by two or three other sprayings, as may seem best, at intervals of ten to fourteen days. If the spraying is done intelligently and the old canes, together with the badly diseased new ones, are removed as soon as the fruiting season is over, there should be no reason why the disease cannot be kept under control.

If there is reason to suspect that the plants are diseased before they are planted, they should be closely trimmed and as soon as growth begins the new shoots should be protected with Bordeaux mixture. The spraying can be very easily and cheaply done at this time, and in localities where attacks of anthracnose have been severe it would, no doubt, prove to be a paying operation even though the plants were supposed to be free from disease when planted.

So much depends on the conditions that are met with each successive season that it is possible to give only general directions for treatment. The experiments show that the disease can be successfully combated by giving proper attention to sanitary conditions and protecting the young canes with Bordeaux mixture. But the questions as to the exact dates on which to apply the treatment, and whether it will pay to spray at all, can only be decided by the grower himself.

IV. FORCING TOMATOES: COMPARISON OF METHODS OF TRAINING AND BENCHING.*

S. A. BEACH.

SUMMARY.

Single-stem training is clearly superior to three-stem training for forcing tomatoes in winter — in this climate. The superiority is seen in the larger yield of early ripening fruit and in the larger total yield. There is but slight difference in the average size of fruit produced under the two methods of training, but on the whole the fruit of the single-stem plants seems to be slightly the larger.

Plants in two or two and a half inch pots plunged in the soil so that roots may be formed above the pot as compared with similar plants knocked out of the pots and planted in the soil on the bench sometimes show slight gain in yield when plants are trained to single stem, but this treatment is a disadvantage when plants are trained to three stems.

INTRODUCTION.

In the larger cities the demand for tomatoes which have been grown under glass begins as soon as the supply of fruit from out of doors is cut off by freezing weather, and it continues till the Florida tomatoes appear in market, which is usually sometime in February. In local markets tomatoes from forcing houses often bring good prices much later than this because they are really superior to the southern grown fruit which is picked before it is ripe, and many persons are willing to pay an extra price for the choice forced tomatoes which are ripened on the vines and delivered fresh to the consumer.

To supply this demand the tomatoes must be ripened during the most unfavorable season for ripening fruit, including as it

*Partial reprint of Bulletin No. 125.

does the short and frequently dark days of December and January. Unlike lettuce, radishes and other vegetables which come to perfection in a comparatively cool temperature, the tomato delights in a warm, sunny location both for setting vigorous fruit abundantly and for ripening it. In growing tomatoes so as to market the fresh fruit during December, January and February, peculiar difficulties are met which do not attend the growing of this fruit in other portions of the year when there is more sunlight.

The inexperienced grower, eager to secure strong, vigorous plants is quite apt to overdo the matter. Either by furnishing an abundance of rich soil in which the plant is allowed to grow unchecked, or by the too liberal use of liquid manure or other fertilizers, he may produce so rank a growth that the plant is unnecessarily slow in coming into bearing.

Those who have had more experience grow thrifty but stocky plants for forcing. They seek a healthy growth yet hold the plant somewhat in check till it has a degree of maturity favorable to the production of fruit. Some gardeners try to prevent too vigorous growth by setting the plants in a very small amount of soil, and later add commercial fertilizers or liquid manure according to the apparent needs of the plant. Excellent results have been secured in this way, but the soil dries out very quickly so that it requires very close attention to the watering.

Others check the root growth by planting in boxes or pots. It is reported that on the island of Guernsey, where large quantities of tomatoes are forced for the London market, the plants are frequently grown in pots. In this country planting in boxes is more frequently advocated. These may be from eight inches to a foot wide, about a foot deep and several feet long, with plants set every two feet. If separate boxes are used for each plant they commonly hold from one to one and a half cubic feet of soil.

Some gardeners plant in an abundance of good soil in beds or on benches where the roots may grow unrestrained and try to control the growth by leading out two of the first shoots, one on each side of the main stem, thus training the plant to three stems as shown in Plate II. The two-foot rule near the center stem

Plate II.—Tomato Plant Showing Method of Training to Three Stems in Forcing House.

PLATE III.—TOMATO PLANT SHOWING FIRST STAGES OF THREE STEM TRAINING; ALSO MANNER OF PRUNING OFF PART OF FOLIAGE TO PREVENT TOO VIGOROUS GROWTH.

will help in forming a correct idea of the size of the plant. These gardeners take off all other shoots and resort to severe pruning of the foliage if necessary, to prevent too rampant growth. Some leaves are removed entirely and others are partly pruned away as shown in the accompanying illustration, Plate III. They hold that the vigorous side shoots, which are allowed to grow in this style of training, have a tendency to check the main or central stem so that no difficulty will be experienced in getting the first clusters of fruit to set within about a foot of the soil.

During the winters 1895-6 and 1896-7 some experiments were made at this Station for the purpose of comparing single-stem with three-stem training. A method of checking the growth which is sometimes used in forcing cucumbers was also tried. It provides for restricting the roots in small pots which are plunged in the soil so that roots may be sent out from the stem above the pot. Plants were grown from the same lots of seed and were carefully selected to get specimens as nearly alike as possible at the start. The soils were very thoroughly mixed and evenly distributed to the plants. In applying fertilizers equal quantities were given to each plant. In short, the aim has been to keep conditions affecting the plants as nearly alike as possible in all points excepting the ones which were to be compared.

We will now consider the tests of single-stem as compared with three-stem training, especially for forcing in winter.

SINGLE–STEM vs. THREE–STEM TRAINING.

EXPERIMENTS OF 1895–6.

First test.

The variety selected for these tests was the Lorillard, which is conceded to be one of the best kinds for winter forcing. Plate IV shows a cluster of Lorillard life size as grown in the forcing house. Some fruits grow considerably larger than those illustrated here and in mid-winter they are often smaller than these. As grown in the forcing house the flesh is quite solid and the seeds are few as shown in Plate V. For a second crop to be fruited in late winter or spring some other variety, like Mayflower, may be preferred.

Seed of Lorillard from a well-known seedsman was sown in flats* August 23, 1895. The flats were filled with soil composed of one measure of sand, one of well-rotted manure and four of potting soil, thoroughly mixed. September 4 the seedlings were transplanted into 2½-inch pots. The soil for the pots consisted of sod from a clay loam piled alternately with layers of coarse stable manure. After this was rotted it was thoroughly mixed and used for potting the plants.

Benching.—The plants were benched September 26th. At this time they varied from 1¼ to 4¼ inches in height and were stocky and healthy. The benches had perforated tile bottoms and were given no extra drainage. Over the tile bottom a thin layer of moss (sphagnum) was spread, then an inch of well-rotted stable manure and lastly an inch of soil. The soil was prepared by mixing thoroughly three measures of the potting soil just described with two and a half measures of sand, two of good leaf mold and two of well-rotted, mixed stable manure. One hundred and three plants were selected for this experiment and were divided into two lots. One lot, consisting of fifty-two plants, was put on the side benches in the east half of the tomato house. These plants were not taken out of the 2½-inch pots which were set immediately on the layer of manure on the bench. The soil was mounded around and over the pot and covered with leaf mold up to the seed leaves (cotyledons) so as to induce the sending out of roots from the stem above the pot. These plants will be referred to on the following pages as being "in pots."

Another lot, consisting of fifty-one plants, was set on the side benches in the west half of the same house. Each plant was taken from the pot, the lower part of the ball of earth attached to it was broken and it was set on the soil on the bench. A mound of earth was then drawn around each plant and covered with leaf mold up to the seed leaves the same as was done with the plants benched in pots as described above. These plants will be referred to hereafter as plants "not in pots," meaning by that, that they were transplanted from the 2½ inch pots to the soil on the bench. Some of the plants in each of the two lots were

*Boxes twelve inches square and three inches deep.

PLATE IV.— LORILLARD. FROM LIFE SIZE PHOTOGRAPH OF FRUIT FORCED IN WINTER.

Plate V.—Lorillard. Showing Section of Fruit Produced in Forcing House.

trained to single stems, all sides shoots being removed and the others were trained to three stems. The accompanying diagram, Plate VI, shows the arrangement of the plants.

The side benches in which these plants were grown are thirty-four inches wide, inside measurement. The plants were set in two rows one six inches from the back side of the bench and one six inches from the front side, the plants in the front row alternating with those in the back row. The single-stem plants stood a foot and a half apart in the row and the three-stem plants twice that distance. This gave to each single-stem plant two and one-eighth square feet of bench room and to each three-stem plant four and one-fourth square feet.

Of the fifty-one plants not in pots, thirty-three were trained to single stem and eighteen were trained to three stems. At the time they were transplanted to the bench, the thirty-three plants for single stem training averaged 3.35 inches high and the eighteen plants for three stem training averaged 2.57 inches high. Thus it appears that when they were benched the single-stem plants averaged .78 of an inch higher than the three-stem plants. A month later, October 28th, they were still in the lead, having an average height of 12.58 inches as compared with 11.25 inches for the three-stem plants. The length of time from seed planting till the first fruit ripened, the average weight per fruit, and the yield in ounces per square foot of bench room, are all summarized in the following table:

TABLE I.— PLANTS NOT IN POTS. TIME OF RIPENING FIRST FRUITS, AVERAGE WEIGHT PER FRUIT, AND YIELD PER SQUARE FOOT OF BENCH.

TRAINING.	Number of plants.	Average days from seed planting till first fruit ripened.	Average weight per fruit in ounces.*	Yield per square foot of bench in ounces.
Single stem	31	157.90	2.00	12.79
Three stem	17	160.15	1.93	11.52

*Quite a number of fruits, which were included in the total yield, were very small and they reduce the average weight per fruit to the amount shown in this and following tables.

EXPLANATION OF PLATE VI.

FIRST TEST.

Three-stem plants in pots, 102 and 1 to 18.

Three-stem plants not in pots, 50 to 67.

Single-stem plants in pots, 68 to 108.

Single-stem plants not in pots, 103 and 19 to 49.

SECOND TEST.

Three-stem plants in pots, 114, 115, 118, 119, 130, 131.

Three-stem plants not in pots, 112, 113, 116, 117, 128, 129, 132.

Single-stem plants in pots, 106, 107, 110, 111, 122, 123, 126, 127.

Single-stem plants not in pots, 104, 105, 108, 109, 120, 121, 124, 125, 133.

The number shows the location of the plant on the bench. Plants 18 and 133 had more room than others of their class and Plant 67 had less. Plants 43 and 98 were accidentally injured. All these were excluded from the experiment.

From this table it appears that the single-stem plants kept the lead from the beginning, ripened their first fruit a few days earlier, gave somewhat greater yield per square foot of bench area occupied by them and produced a little larger fruit on the average than did the plants trained to three stems.

Of the fifty-two plants in pots, thirty four were trained to single stems and eighteen to three stems. When they were put on the benches, the plants selected for single-stem training averaged 2.45 inches high and those selected for three-stem training averaged 3.33 inches, so the plants which were designed for three-stem training averaged .88 of an inch higher than the single-stem plants. A month later, October 28, the three-stem plants were still in the lead, having an average height of 9.75 inches, which was 1.44 inches more than the average of the single-stem plants. The time of ripening the first fruits, the average weight per fruit, and the yield are shown in the following table:

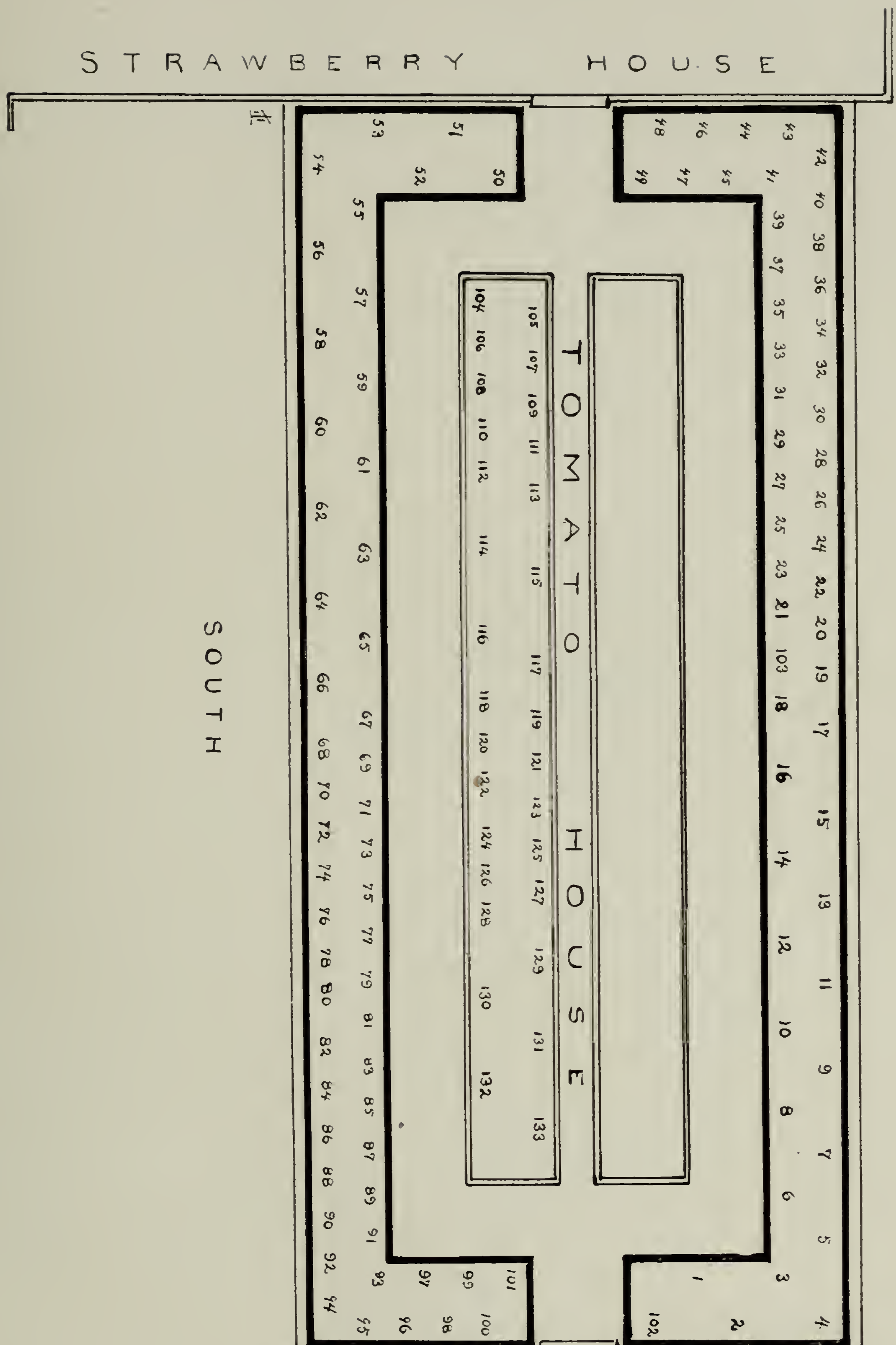


PLATE VI.—DIAGRAM OF TOMATO HOUSE, 1895-6.

TABLE II.—PLANTS IN POTS, TIME OF RIPENING FIRST FRUITS, AVERAGE WEIGHT PER FRUIT, AND YIELD PER SQUARE FOOT OF BENCH.

TRAINING.	Number of plants.	Average days from seed planting till first fruit ripened.	Average weight per fruit in ounces.*	Yield per square foot of bench in ounces.
Single-stem	33	160.15	1.76	13.21
Three-stem	17	159.17	2.04	11.74

*See note, Table I.

In this case, as in the one given above, the single-stem plants eventually took the lead in the yield per square foot of the bench area which they occupied, although at the time they were put on the benches and for at least a month afterwards the three-stem plants were the larger. These three-stem plants gave larger sized fruits than did the corresponding single-stem plants.

In tests which were made the following season, it was shown that the north side-bench was a more favorable location for tomatoes during the winter months than the south side-bench. This is, no doubt, largely due to the fact that the purlin and the eaves are rather wide, and shade the plants on the south bench to a considerable extent. Since the single-stem plants in pots were located on the south side-bench, while the corresponding three-stem plants had the more favorable location on the north side-bench and were larger plants at the time they were benched, the fact that the single-stem plants gave the larger yield per square foot is all the more significant.

SECOND TEST.

Some Lorillard plants which had been started in flats and transplanted to 2½-inch pots in a way similar to that described under the first test, were set on the south middle-bench of the tomato house December 12, 1895. The plan of arrangement is shown in the diagram, Plate VI. The bench was prepared by putting a layer of moss (sphagnum) over the bottom and covering this with about 2½ inches of potting soil like that used for the first test. First a group of plants for single stem-

training was put on the bench, then a group designed for three stem training, then another group for single-stem training and lastly a group of three-stem training. Half of the plants were kept in the 2½-inch pots, and the earth was mounded over the pots up to the seed leaves. The others were knocked out of the pots and transplanted directly to the bench. First a plant not in a pot was transplanted to the bench, then a plant in a pot was placed on the bench, thus alternating the two classes till the bench was filled. By this arrangement the differences in light and temperature for the two classes of plants were not great enough to materially affect the results of the test.

The plants were set in two rows, those in the front row coming opposite the middle of the space between the plants in the back row. Plants for single-stem training were put eighteen inches apart; those designed for three-stem training were set three feet apart. As this bench measured thirty-eight inches wide inside measurement this made the area allotted to each single-stem plant 2⅜ square feet and that for each three-stem plant 4¾ square feet.

Of the sixteen plants which were taken out of the pots and transplanted to the bench, nine, averaging 5.94 inches in height, were for single-stem training, and seven, averaging 5.93 inches in height were for training to three stems. Thus it appears that there was practically no difference in the average height of the two classes of plants when they were benched. The following table summarizes their record.

TABLE III.—PLANTS NOT IN POTS. TIME OF RIPENING FIRST FRUITS, AVERAGE WEIGHT PER FRUIT, AND YIELD PER SQUARE FOOT OF BENCH ROOM.*

TRAINING.	Number of plants.	Average days from benching till first fruits ripened.	Average weight per fruit in ounces.†	Yield per square foot of bench in ounces.
Single-stem	9	99.78	2.87	20.26
Three-stem	7	97.71	2.79	15.97

* See foot note, p. 253.
† See note, Table I.

In this case the three-stem plants on the average ripened their first fruits a little earlier than the single-stem plants, but the single-stem plants yielded at the rate of twenty-seven pounds more fruit per hundred square feet of bench and their fruits averaged slightly larger than those of the three-stem plants.

Of the fourteen plants in pots, eight, averaging 5.91 inches in height, were for single-stem training and six, averaging 5.92 inches high, were for three-stem training. Thus it appears that the two lots of plants averaged practically the same in height at this time. The following is a summary of their later records.

TABLE IV.—PLANTS IN 2½ INCH POTS PLUNGED ON THE BENCH. TIME OF RIPENING FIRST FRUITS, AVERAGE WEIGHT PER FRUIT, AND YIELD PER SQUARE FOOT OF BENCH.*

TRAINING.	Number of plants.	Average days after benching till first fruits ripened.	Average weight per fruit in ounces.†	Yield per square foot of bench in ounces.
Single-stem	(8)	(108.38)	(2.55	(17.58)
Single-stem	7	102.57	2.58	19.42
Three-stem	6	96.00	2.72	15.34

* Some of the items do not agree with those which were published in Bulletin 125, because the tables have been corrected, an error in transcribing the record having been discovered.

† See note, Table I.

For some unknown reason one of the single-stem plants was very late in ripening its first fruits and was very unproductive, yielding but a few undersized fruits. By including the records of this plant in the averages, as is done in the first line of the table where the figures appear in small type and in parentheses, it gives a wrong impression of the general character of this lot of plants. Leaving this plant out, as is done in the second line of the table, a more just comparison with the corresponding three-stem plants may be made. It then appears that while the single-stem plants ripened their first fruits somewhat later than did the three-stem plants, and the fruit averaged slightly smaller, yet they gave a greater yield, the increase being at the rate of 25½ pounds per hundred square feet of the bench area which they occupied.

Temperature of the house during the winter.—The range of temperature for the house during the winter is indicated by the following table which shows the daily temperature at the east and west ends of the house taken at 7 a. m., 12 m. and 6 p. m. The records are averaged by weeks from September 28, 1895 to March 14, 1896, a period of twenty-four weeks. In twelve cases, or just half the time, the weekly average for 7 a. m. at the west end was slightly higher than at the east end, the difference varying from 0.13° to 2.00°. The weekly average at the east end at noon was higher than at the west end in ten cases, and one week the noon average was the same for both ends of the house. The weekly average for 6 p. m. was higher at the west than at the east end in but seven instances. From November 22 to February 8 the 6 p. m. average was uniformly lower at the west end. This may be accounted for by the fact that during the short days of winter the head greenhouse, into which the west end of the tomato house opens, cuts off the sunlight from that end of the house during the latter part of the afternoon.

DATE.	AVERAGE PER WEEK.					
	EAST END.			WEST END.		
	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.
Sept. 28–Oct. 4, 1895	56.50	69.57	61.25	56.43	66.93	61.17
Oct. 5–11	60.43	72.00	64.14	59 97	70.86	60.57
Oct. 12–18	53.79	67.57	60.86	55.79	66.57	61.07
Oct. 19–25	56.29	64.57	58.93	57.57	69.58	61.57
Oct. 26–Nov. 1	58.43	65.29	62.00	57.86	66.71	61.71
Nov. 2–8	60.64	74.29	65.29	61.33	70.00	64.57
Nov. 9–15	56.93	64.79	57 58	57.57	65.50	61.08
Nov. 16–22	60.14	69.93	65.07	58.71	72.00	65.71
Nov. 23–29	61.93	71.93	66.29	60.43	68.29	63.14
Nov 30–Dec. 6	55.21	66.57	62.14	54 93	68.29	61.79
Dec. 7–13	55.71	66.93	63.29	56.07	63.00	62.36
Dec. 14–20	63.86	69.80	65.83	63.71	66.30	63.40
Dec. 21–27	60.43	67.50	63.29	61.00	68.67	62.67
Dec. 28–Jan. 3, 1896	55.86	65.71	63.14	56.14	65 57	62.14
Jan. 4–10	60.86	66 57	64.17	59.86	69.71	62.67
Jan. 11–17	61.50	68.80	69.20	60.25	72.00	66.40
Jan. 18–24	64.43	72.50	69.43	64.00	71.67	67.33
Jan. 25–31	62.50	73.25	71.67	64 00	72 33	68.67
Feb. 1–7	65.29	77.50	69 57	64.57	73.00	66.14
Feb. 8–14	64.57	71.80	67.50	64.17	76 00	68.00
Feb. 15–21	65.14	76.86	66.14	66.00	75.67	66.86
Feb. 22–28	67.71	73.57	70 57	68.57	72.14	70.43
Feb. 29–March 6	67.14	76.43	67.29	67.57	78.14	65.71
March 7–13	68.00	72.43	63.00	68.43	72.43	65.00
Average	60.98	70.26	64.90	61.04	70 06	64.17

Experiments of 1896-97.

Third Test.

Seed of Lorillard for a third test was planted in flats August 15, 1896, in a soil composed of equal measures of well-rotted manure, sand, leaf-mold and loam, all thoroughly mixed. About half an inch of drainage was placed in the bottom of the flats. By using a marker* to make the furrows, the seed was planted at uniform depth. The seeds were put about one-fourth inch apart in the row.

On the eighth day the seeds began to germinate and all which germinated on that day were marked for transplanting. Nearly five hundred of the plants which germinated August 23d were pricked off from the flats into two-inch pots September 2d, and plunged in moss on a greenhouse bench so that the conditions of moisture, light and heat for the entire lot could be kept as nearly uniform as possible.

Rainy weather interfered with the proper preparation of soil so that the plants were not transplanted to the benches till October 22d. The plants were still in good condition but they would have been transplanted earlier had it not been for the delay in preparing soil for the benches.

Soil for benches.—The soil for the benches was prepared by mixing thoroughly one measure of leaf-mold, one of sand, one of horse manure pretty well rotted and turned several times, and one of loam. The loam was composted sod piled in alternate layers with manure, well-rotted and well-mixed. Enough of this soil was prepared to fill benches six inches deep having an area of six hundred square feet. To this was added fourteen pounds of a fertilizer mixture composed of six parts by weight of acid phosphate having 14 per cent available phosphoric acid and four parts by weight of high-grade sulphate of potash containing the equivalent of 50 per cent actual potash. This is at the rate of five hundred pounds of the mixture per acre, taking into account simply the area of bench surface.

*The marker consisted of a short board on which were fastened parallel strips of wood one-fourth of an inch thick. By pressing the marker on the soil furrows were made by these strips which were uniformly one-fourth of an inch deep.

Selection of plants.—From the nearly five hundred plants which had germinated in one day and which now were growing in two-inch pots, sixty fine, healthy plants were selected for the test. The size of the plants at this time may be seen by referring to Plate VII, which is from a photograph of one of the plants after it was knocked out of the pot and ready for transplanting. Enough plants for the test could not be found which were uniform in height so those which were selected were assigned to places on the benches as follows:

Twenty plants each 6½ inches high for single-stem training on the north bench.

Ten plants each 7 inches high for three-stem training on the north bench.

10 plants each 6¼ inches high } for single-stem training on the
10 plants each 6¾ inches high } south bench.
5 plants each 7¼ inches high } for three-stem training on the
5 plants each 7½ inches high } south bench.

It will be observed that the plants for single-stem training on the south bench averaged 6½ inches, which is the height of each of the single-stem plants assigned to the north bench. The sequel did not show that the slight differences in the height of the plants when they were transplanted to the bench, made any perceptible

EXPLANATION OF PLATE VIII.

The number shows the location of the plant on the bench. On account of their location Plants 1 and 62 were not included in the experiment; Plant 2 was discarded because its roots found their way under a partition into the soil of another part of the bench, and Plants 11 and 31 were discarded on account of accidental injury.

Three-stem plants in pots, 14, 15, 27, 30, 31, 42, 43, 46, 58 and 59.

Three-stem plants not in pots, 12, 13, 16, 28, 29, 44, 45, 57, 60, 61.

Single-stem plants in pots, 2, 3, 6, 7, 10, 11, 18, 19, 22, 23, 26, 34, 35, 38, 39, 47, 50, 51, 54, 55.

Single-stem plants not in pots, 1, 4, 5, 8, 9, 17, 20, 21, 24, 25, 32, 33, 36, 37, 40, 41, 48, 49, 52, 53, 56, 62.

PLATE VII.—TOMATO PLANT READY FOR TRANSPLANTING TO BENCH OF FORCING HOUSE.

PLATE VIII.—DIAGRAM OF TOMATO HOUSE, 1896-7.

differences in the yields.* The tests which were made the previous winter indicated that the three-stem training gives a smaller yield on the same area of bench than the single-stem training. For this reason the tallest plants were assigned to three-stem training so that there might be no appearance of favoring the single-stem plants in planning the test. For the same reason the tallest three-stem plants were put on the south bench as the previous season's test indicated that the shading of the bench by a purlin made that a less favorable location than the north bench.

Planting on benches.—October 22 the plants were moved to permanent places on the side benches of the tomato house and arranged as shown in the accompanying diagram, Plate VIII.

The plan of the previous season was followed in that no drainage was put on the bottom of the bench, as it was thought that the perforated tile furnished ample drainage. Five quarts of soil were mounded around each plant. Part of the plants were transplanted to this soil and part were left in the pots in which they were growing and the soil was spread under and mounded over the pot. They will be referred to, the same as on previous pages, as " plants in pots " and " plants out of pots."

The plants were set in two rows, one row ten inches from the front the other ten inches from the back of the bench. The benches are thirty-four inches wide, inside measurement. The plants in the front row alternated with those in the back row so that each plant came opposite the middle of the space between

*In some instances plants which were the taller at the time of transplanting were more productive and in some cases they were less productive than the shorter plants. The average yields are as follows:

No. of plants.	Training.	Height when transplanted: Inches.	Average yield per plant: Ounces.
4.	Single-stem in pots	6.25	58.44
6.	Single-stem not in pots	6.25	58.54
5.	Single stem in pots	6.75	53.25
5.	Single-stem not in pots	6.75	61.25
3.	Three-stem in pots	7.25	88.00
2.	Three-stem not in pots	7.25	106.125
2.	Three-stem in pots	7.50	57.50
3.	Three-stem not in pots	7.50	97.83

The three-stem plants which measured 7½ inches at the time of transplanting were less productive than the three-stem plants which measured 7¼ inches. This may be partly accounted for by the fact that the former were nearer the west end of the house and during the short days of winter became shaded from the sun earlier in the afternoon than those towards the middle or east end of the house.

two plants in the other row. The plants in pots were not grouped as in the first test but were alternated with plants out of pots, first a plant in a pot then a plant out of a pot and so on throughout the house. This was done both with single-stem and with three-stem plants.

It was thought that in the first test the plants were crowded too closely together, so in this test the single-stem plants were set two feet apart in the row thus allowing each plant $2\frac{5}{6}$ square feet of bench surface. The three-stem plants were four feet apart in the row thus giving each of them an area of $5\frac{2}{3}$ square feet.

Adding soil to benches.— The mound of earth which was put around the plants as they were transplanted to the benches was covered with moss (sphagnum) to prevent the too rapid evaporation of moisture. The moss served this purpose admirably. December 30, a layer of about an inch of soil was covered over all the bench. In about a week the plants began to fill this new soil with roots. Another layer of about two inches of soil was added to the benches March 16, and April 19 a third layer of about two inches. June 1, all fruit, both green and ripe, was picked and the experiment was closed.

Plants not in pots.— Of the thirty plants not in pots twenty were trained to single-stem and ten to three stems. The single-stem plants averaged 1.94 inches high when pricked off and 6.49 inches when benched. The plants for three-stem training averaged 2.00 inches when pricked off and 7.20 inches when benched. The more vigorous plants were assigned to three-stem training yet eventually the single-stem plants gave the larger yield as shown by the following table:

TABLE V.— PLANTS NOT IN POTS.—TIME OF RIPENING FIRST FRUITS, AVERAGE WEIGHT PER FRUIT AND YIELD PER SQUARE FOOT OF BENCH.

TRAINING.	Number of plants.	Average days from seed planting till first fruit ripened.	Average weight per fruit in ounces.*	Yield per square foot of bench.
Single-stem	20	172.45	2.77	24.56
Three-stem	10	171.30	2.49	19.53

*See note, Table I.

In this test the three-stem plants were in four groups, two on the north bench and two on the south bench, alternating with corresponding groups of single-stem plants. This arrangement secured more uniform conditions than could be secured by the plan adopted for the first test. The results here set forth are therefore considered more satisfactory and more reliable than those which appeared with the first test. They do not conflict with the conclusions drawn from the first test but rather emphasize them. The single-stem training, other things being equal, gives decidedly better results than the three-stem training both in yield and in average size of fruit produced. Although the first fruits ripened on the average a day earlier on the three-stem plants than on the single-stem plants, yet in the amount of fruit ripened early the single-stem plants again take the lead as is shown in the following statement of the yield by weeks for the first six weeks after the first fruit was picked:

TABLE VI.— PLANTS NOT IN POTS.—YIELD FOR SIX WEEKS AFTER FIRST FRUIT RIPENED.

TRAINING.	Number of plants.	YIELD IN OUNCES PER FIFTY ONE SQUARE FEET OF BENCH.*						
		First week.	Second week.	Third week.	Fourth week.	Fifth week.	Sixth week.	Total for six weeks.
Single-stem	20	10.35	38.93	81.00	17.33	40.73	66 83	255.17
Three-stem.........	10	4.50	36.00	54.00	21.83	9.90	16.20	142.43

*This area is taken as a basis for making this table, so that this may be compared with Table VIII, page 262.

This table shows clearly the superiority of single-stem training in producing fruit early, while Table V shows its superiority in total yield for the season. It will be noticed that the yield drops at the fourth week and then gradually increases. The falling off in yield which begins at the fourth week is due to the difficulty experienced in getting fruit to set during the latter part of December and early in January. As the days get longer and the amount of light increases the fruit sets more readily. When there is an abundance of sunshine, simply jarring the blossoms as may be done by rapping the plants with a padded stick, will

cause the fruit to set well. During periods of little sunshine, especially when the days are shortest, more difficulty is experienced in getting the fruit to set. The blossoms that are not properly fecundated soon fall off as shown in Fig. 16. When the weather is not favorable for the setting of fruit the blossoms should be pollinated by hand during the driest part of every second or third day. This may be done by jarring the open flowers over a camel's hair brush or small spoon and touching the stigma with the pollen that has thus been gathered. By passing from flower to flower in this way the blossoms become fertilized satisfactorily. Small and one-sided fruit which is liable to be found on plants in the forcing house in winter, may be due either to an insufficient supply of pollen or to close fertilization, that is to say, to the fertilizing of the blossom with its own pollen exclusively.*

Plants in pots.—Of the thirty plants which were assigned to this part of the test, two were discarded because they were accidentally injured. A third was thrown out because it sent its roots under a partition and into the soil of an adjacent part of the bench. By its rampant growth it soon showed that it had reached

*Fink, who has made some very interesting observations in this line,** finds that:

1. The vigor of the fruit is seen soon after pollination takes place. "Of two flowers pollinated at about the same time, one is sometimes half grown before the other makes more than enough growth to make certain the fact that fertilization has taken place. The one that makes this rapid growth from the start ripens nearly as much in advance and is larger than the one that stops growing for a time. * * * I think there are two causes for this difference in development, *i. e.*, insufficient pollination and insufficient nourishment."

2. The amount of pollen applied to the stigma influences the size and shape of the fruit. "Tomatoes produced from large amounts (of pollen) were large and regular, produced a large number of seeds and did not fail to come to maturity in a single instance; while those from small amounts were smaller in size, had fewer seeds, were not so regular in shape and several stopped growing at the size of a pea. * * * I tried cutting off one side (of the stigma). The result is usually a one-sided tomato but not always. * * * I also tried pollinating one side only and got one-sided fruit as a result."

3. Pollination may be done effectively during the first four to eight days after the blossom opens. The best time to get pollen for applying to the stigmas is about two days after the blossoms open, when the anthers or pollen sacs begin to open. "The pollen sacs open sooner (after the blossoms open) in small than in large flowers and sooner in dry than in wet weather. * * * The best time to pollinate artificially is in the driest part of the day."

4. On the whole, fruits produced by close pollination "are below average size and usually contain fewer than the average number of seeds."

**Fink, Bruce, Pollination and Reproduction of Lycopersicum Esculentum. Bull. Geol. and Nat. Hist. Surv. Minn., 9: 636-643. 9 N. 1896.

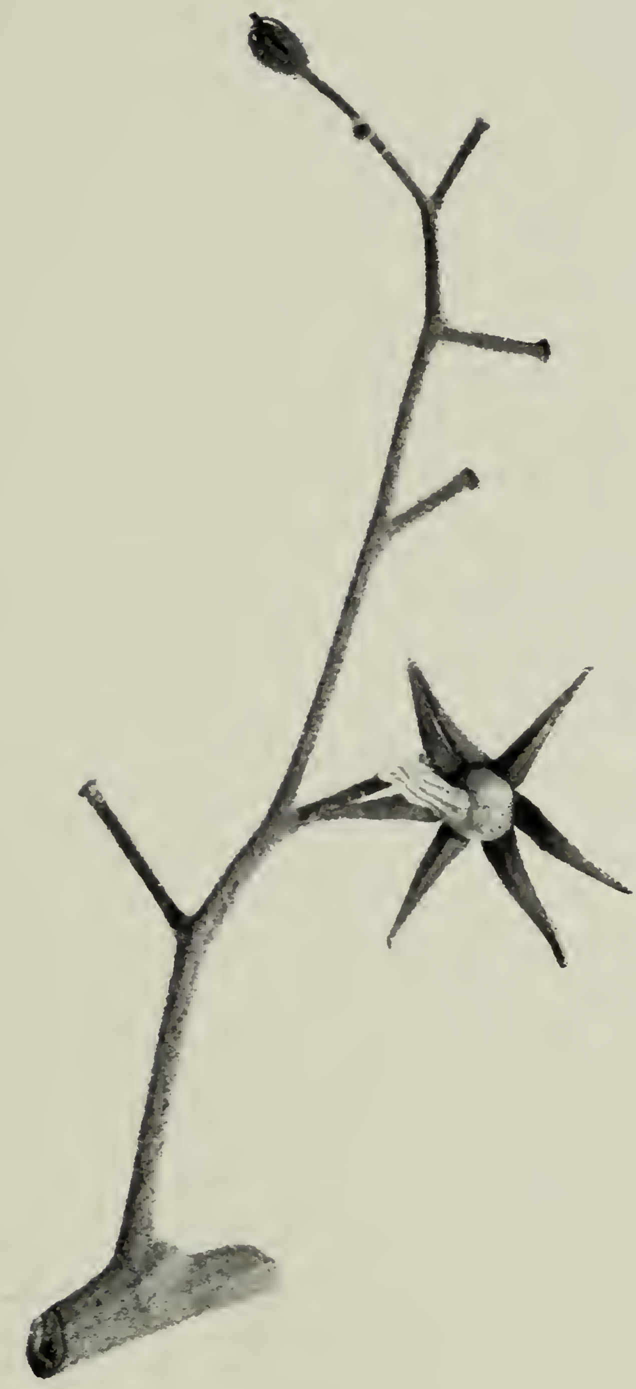


Fig 16.—The Fruit Fails to Set When the Stigma is not Properly Pollinated.

a supply of food not available to its neighbors and during the rest of the winter it was allowed to stand as an object lesson on the bad effects of over-feeding tomatoes in the forcing house. Of the twenty-seven plants finally included in this part of the test, eighteen were trained to single stem. These averaged 1.80 inches high when they were pricked off and 6.00 inches when they were benched. Nine corresponding plants designed for three-stem training averaged 2.05 inches high when they were pricked off and 7.15 inches when they were benched. In this case, although the more vigorous plants were assigned to three-stem training, the single-stem plants eventually out-yielded them as the following table shows:

TABLE VII.—PLANTS IN POTS. TIME OF RIPENING FIRST FRUITS, AVERAGE WEIGHT PER FRUIT AND YIELD PER SQUARE FOOT OF BENCH.

TRAINING.	Number of plants.	Average days from seed planted till first fruit ripened.	Average weight per fruit in ounces.*	Yield per square foot of bench.
Single-stem	18	173.78	2.84	23.20
Three-stem	9	168.89†	2.45	16.04

*See Table I, Note 1.
†This is the average for eight plants as the first flower cluster on one plant was cut off by an insect, thus delaying the setting of the first fruit.

As explained in discussing Table V, page 258, the plants in this test were so arranged on the benches that more uniform conditions were secured than was possible with the plan which was followed in the first test. The superiority of the single-stem training, both in size of fruit and in total yield is again emphasized by this table. Although the three-stem plants ripened their first fruit an average of five days earlier than the single-stem plants, yet in the amount of fruit ripened during the six weeks after the first fruit was picked the single-stem plants were ahead, as the following table shows:

TABLE VIII.—PLANTS IN POTS. YIELD FOR SIX WEEKS AFTER FIRST FRUIT RIPENED.

TRAINING.	Number of plants.	OUNCES PER FIFTY-ONE SQUARE FEET OF BENCH.*						
		First week.	Second week.	Third week.	Fourth week.†	Fifth week.	Sixth week.	Total for six weeks.
Single-stem......	18	4.75	27.25	87.50	30.00	16.75	46.00	212.25
Three-stem	9	4.50	40.50	27.00	4.75	18.00	29.50	124.25

*Fifty-one square feet is the bench area actually occupied by each lot of plants. Compare with Table VI.

†The decrease in yield at this period is considered in the discussion which follows Table VI. See page 259.

PLANTS KEPT IN SMALL POTS AND PLUNGED IN THE SOIL ON THE BENCH VS. PLANTS TRANSPLANTED TO THE BENCH.

In the first pages of this bulletin, while setting forth some of the considerations which led to an investigation of the merits of single-stem training as compared with three-stem training, the necessity of avoiding too rampant a growth in forcing tomatoes was considered and some of the various ways of holding the plants in check were mentioned. In forcing cucumbers, some gardeners plant the seed in small pots, like two-inch pots, and do not move the plants from these pots. When they are ready to be put in permanent place on the bench for fruiting the pot containing the plant is plunged in the soil on the bench. The soil is mounded over the pot so that new roots are sent out from the stem above the pot. It has been stated on previous pages that in tests conducted during the winters of 1895-6 and 1896-7 some of the potted tomato plants were plunged into the bench soil in pots after the method used in forcing cucumbers, and other plants were knocked out of the pots and transplanted directly to the bench soil. These two methods will now be compared. The records of these plants have been given in another connection on previous pages, and the methods of sowing seed, selecting plants, preparing soil, training, etc., may be found by consulting those pages.

Experiments of 1895–6.

First Test Using Single-stem Plants.

September 26, 1895, sixty-seven plants were put on the benches of the tomato house for training to single stem, thirty-three of which were transplanted to the soil on the bench. These are referred to in this bulletin as plants "not in pots." The remaining thirty-four plants were plunged in the soil of the bench in the 2½-inch pots in which they were growing and the soil was mounded over the top of the pot so as to favor the sending forth of roots from the stem above the pot. These are referred to as plants "in pots." The arrangement of the two lots of plants may be seen by consulting the diagram, Plate VI.

At the time they were put on the benches the plants in pots had an average height of 2.45 inches and the corresponding plants not in pots averaged 3.35 inches high. On account of this difference in size the two classes of plants may not be strictly comparable, but as they may give some indication of the comparative value of the two methods of treatment, their records are given for what they are worth.

By October 5 many of the plants in pots were sending out roots above the pots, which soon filled the surrounding soil. They did not make as vigorous growth as the corresponding plants out of pots did, but it must be remembered that they were somewhat smaller plants to start with. Besides this, they occupied one-half of the south bench which, as has already been pointed out, page 251, is a less favorable location for forcing tomatoes in winter than is the north bench on which the plants not in pots were located. The arrangement of the plants may be seen by consulting the diagram, Plate VI.

October 28, about a month after they were benched, the plants in pots averaged 8.31 inches high and those not in pots averaged 12.58 inches. Their later record is summarized in the following table:

TABLE IX —SINGLE-STEM PLANTS. TIME OF RIPENING FIRST FRUITS, AVERAGE NUMBER OF FRUITS PER PLANT, WEIGHT PER FRUIT AND YIELD PER SQUARE FOOT OF BENCH.

METHOD OF BENCHING.	Number of plants.	Average days from seed planting till first fruit ripened.	Average weight per fruit in ounces.	Average number of fruits per plant.	Yield in ounces per square foot of bench.
In pots	33	160.15	1.76	15.97	13.21
Not in pots	31	157.90	2.00	13.60	12.79

Second Test Using Single-stem Plants.

Plants were arranged on the south middle bench of the tomato house December 12, 1895, for a second test. The plan of treatment which was followed has already been given, see page 251. The location of the plants on the bench may be seen by consulting the diagram, Plate VI. Of the seventeen plants in this test which were trained to single stem, eight were in pots and nine were not in pots. In discussing Table IV, page 253, it was shown that one of the plants in pots was very late in ripening its first fruits and was very unproductive, yielding but few small fruits. In the following table the first line, where the numbers are given in parentheses, includes the record of this exceptional plant, while the record in the following line excludes the record of this plant and therefore gives a much better idea of the general character of this lot of plants.

TABLE X.—SINGLE-STEM PLANTS. TIME OF RIPENING FIRST FRUITS, AVERAGE NUMBER OF FRUITS PER PLANT, WEIGHT PER FRUIT AND YIELD PER SQUARE FOOT OF BENCH.

METHOD OF BENCHING.	Number of plants.	Average days from benching till first fruit ripened.	Average weight per fruit in ounces.	Average number of fruits per plant.	Yield in ounces per square foot of bench.
In pots	(8)	(108.38)	(2.55)	(16.38)	(17.58)
In pots	7	102.57	2.58	17.86	19.42
Not in pots	9	99.78	2.87	16.78	20.26

When they were put on the bench, the plants in pots averaged 5.91 inches high and the plants out of pots 5.94 inches. With respect to size the two lots of plants started on practically an equal footing, and may be considered comparable, after discarding one of the plants in pots, which sent its roots into the soil of an adjacent bench, as above explained. The table shows that the plants in pots gave a larger number of fruits than the plants not in pots, but they were a little late in ripening first fruits, their fruit was slightly smaller and the yield per square foot of bench was a little less, so that nothing was gained by keeping the plants in pots.

Experiments of 1896-7.

Third Test Using Single-stem Plants.

Seed of Lorillard for this test was sown Aug. 15, 1896. The method of selecting the plants, the arrangement on the benches, the preparation of soil, etc., are all explained on previous pages. See pages 255 to 258. Forty plants were selected for single-stem training, twenty to be grown in pots and twenty out of pots. Because of accidental injury, two of the plants in pots were thrown out of the experiment. The following statement permits of a comparison of the growth of the two lots during the early part of the experiment.

Table XI.—Single-Stem Plants. Height of Young Plants.

Method of benching.	No. of plants.	Average Height in Inches.		
		When pricked off. Sept. 2d.	When benched. Oct. 22d.	Two weeks after first blossoms opened. Nov. 19th.
In pots	18	1.85	6.51	14.40
Not in pots	20	1.94	6.49	14.81

These figures show that during the early periods of growth the plants were remarkably uniform. The records concerning their yield are summarized in the following table:

TABLE XII. — SINGLE-STEM PLANTS — TIME OF RIPENING FIRST FRUITS, AVERAGE NUMBER OF FRUITS PER PLANT, WEIGHT PER FRUIT AND YIELD PER SQUARE FOOT OF BENCH.

METHOD OF BENCHING.	Number of plants.	Average days from seed planting till first fruit ripened.	Average weight per fruit in ounces.	Average number of fruits per plant.	Yield in ounces per square foot of bench.
In pots	18	173.78	2.84	23.17	23.20
Not in pots	20	172.45	2.77	25.15	24.56

These two lots of plants are certainly comparable as great care was used to select uniform plants and to give them similar conditions from the time the seed was planted till the last fruit was picked, excepting only that one lot was in pots and the other was not in pots. In this case the results are slightly different from those of the first and second tests as set forth in Tables IX and X. The plants in pots again ripened the first fruits later, and the yield was slightly less than that of the plants not in pots, but the average weight per fruit was slightly greater. In no case is the difference marked with single-stem plants and the testimony favors the conclusion that little or no advantage is gained by growing them in pots in the way they were grown for these tests.

The influence of benching in pots when plants are trained to three stems will now be considered.

EXPERIMENTS OF 1895–6.

First Test Using Three-stem Plants.

The plants designed for three-stem training which were put on the benches September 26, 1895, were arranged as shown in the diagram, Plate VI. This arrangement proved to be faulty, inasmuch as the lots of plants to be compared were separated into groups, and these groups, being located in different parts of the house, did not have equal exposure to sunlight, as has already been explained on page 251. For this reason the results of the first test are not considered wholly satisfactory.

The three-stem plants were separated into two lots. The plants of one lot were grown in small pots plunged in the soil of

the bench, as has already been explained, and the plants of the other lot were knocked out of the small pots at the time they were transplanted to the benches. The eighteen plants in pots averaged 3.33 inches high when they were benched and about a month later, October 28th, they averaged 9.75 inches. The location which they were given proved more favorable than that of the corresponding plants not in pots. The plants not in pots averaged 2.57 inches high when they were benched and 11.25 inches October 28th. Records are summarized in Table XIII for the seventeen plants of each lot which were finally included in the experiment.

Table XIII. — Three-stem Plants. Time of Ripening First Fruits, Average Number of Fruits Per Plant, Weight Per Fruit and Yield Per Square Foot of Bench.

Method of benching.	Number of plants.	Average days from seed planting till first fruit ripened.	Average weight per fruit in ounces.	Average number of fruits per plant.	Yield in ounces per square foot of bench.
In pots	17	159.17	2.04	24.94	11.97
Not in pots	17	159.50	1.93	25.35	11.52

Second Test Using Three-stem Plants.

In arranging plants for the second test the plants in pots were alternated with plants out of pots throughout the bench so that the two classes of plants in this test are strictly comparable. The method of selecting plants and the plan of treatment has already been explained on page 251. The diagram, Plate VI, shows the location of the plants on the south middle bench of the tomato house.

The six plants in pots which were included in this test averaged 5.92 inches high December 12 when they were benched and 22.08 inches about a month later, January 14. The seven corresponding plants not in pots averaged 5.93 inches high when they were benched and 20.29 inches January 14. From their succeeding records the following table is derived:

TABLE XIV.—THREE-STEM PLANTS. TIME OF RIPENING FIRST FRUIT, AVERAGE NUMBER OF FRUITS PER PLANT, WEIGHT PER FRUIT AND YIELD PER SQUARE FOOT OF BENCH.

METHOD OF BENCHING.	Number of plants.	Average days from benching till first fruit ripened.	Average weight per fruit in ounces.	Average number of fruits per plant.	Yield in ounces per square foot of bench.
In pots	6	96	2.72	26.50	15.34
Not in pots	7	97	2.79	27.14	15.97

In this case as with single-stem plants, the two methods of benching which were tried showed no striking difference in results. The third test will now be considered.

EXPERIMENTS OF 1896–7.

Third Test Using Three-stem Plants.

Seed of Lorillard for this test was sown August 15, 1896. The method of selecting the plants, the preparation of the soil, etc., are explained on pages 255 to 258.

The plants in pots were benched alternately with plants out of pots as in the second test, and the two lots of plants are considered strictly comparable. Of the twenty plants selected for three-stem training ten were not grown in pots and ten were kept in pots. One of the plants in pots was accidentally broken and was thrown out of the test. The records show a remarkably uniform growth of the young plants as may be seen from the following table:

TABLE XV.—THREE-STEM PLANTS. HEIGHT OF YOUNG PLANTS.

METHOD OF BENCHING.	Number of plants.	AVERAGE HEIGHT IN INCHES.		
		When pricked off Sept. 2.	When benched Oct. 22.	Two weeks after first blossoms opened.* Nov. 19.
In pots	9	2.08	7.19	12.19
Not in pots	10	2.00	7.20	12.80

*With the three-stem plants the tips of the main stems were pinched out just beyond the first flower cluster, so as to favor the growth of the side shoots for the three-stem training. On this account the height of three-stem plants should not be compared with the height of the single-stem plants on November 19th.

From the complete records of the test the following table is derived:

TABLE XVI. THREE-STEM PLANTS. TIME OF RIPENING FIRST FRUITS, AVERAGE NUMBER OF FRUITS PER PLANT, WEIGHT PER FRUIT AND YIELD PER SQUARE FOOT OF BENCH.

METHOD OF BENCHING.	Number of plants.	Average days from seed planted till first fruits ripened.	Average weight per fruit in ounces.	Average number of fruits per plant.	Yield in ounces per square foot of bench.
In pots	9	168.89*	2.45	37.11	16.04
Not in pots	10	171.30	2.49	44.40	19.53

*This is the average for eight plants as the first flower cluster on one plant was cut off by an insect, thus delaying the setting of the first fruit.

In this case the plants in pots ripened their first fruits a little earlier but yielded less weight of fruit than the plants not in pots, the difference being at the rate of twenty and a half pounds per hundred square feet of bench.

CONCLUSIONS.

These tests of single-stem vs. three-stem training and of plants plunged on the bench in small pots vs. transplanted plants not in pots have been continued two seasons. Not counting the plants which have been discarded during the course of the experiments, sixty-six three-stem plants and one hundred and nineteen single-stem plants have been under test making a total of one hundred and eighty-five plants.

Only one variety has been used in the experiments but that is one almost universally used by gardeners in this country for winter forcing, namely, the Lorillard. The tests have been conducted on a sufficiently extensive scale so that the results are conclusive so far as this variety is concerned. Probably with other varieties they would be somewhat modified in detail, but the general results would doubtless be the same whatever the kind of tomato used.

It is not to be expected, however, that single-stem plants will outyield three-stem plants in every instance regardless of the influences which surround them. Various things influence the productiveness of tomato plants and the skillful gardener studies to combine all these influences to the end that he may get a large yield of fruit of marketable size. In the hands of a skillful gardener plants trained to three stems may do better than the same plants trained to single stems would do in the hands of an unskillful man. In other words, the advantage gained by training tomatoes to single stems in the forcing house are not great enough to overcome the results of neglect or lack of skill.

We are confident that, other things being equal, the different methods under consideration will give results in accordance with the conclusions which are given below.

Single-Stem vs. Three-Stem Training.

The single-stem training is clearly superior to three-stem training for winter forcing of tomatoes in this climate, both in the amount of fruit ripened early in the season and in the yield on equal areas. There is but slight difference in the average size of fruit produced but on the whole the fruit on single-stem plants seems to average slightly larger than that on three-stem plants.

Plants Benched in Pots vs. Plants Benched not in Pots.

Plants kept in small pots and plunged in soil on the bench as compared with similar plants taken from the pots and transplanted to the bench sometimes show slightly more satisfactory results when the plants are trained to single-stem. When the plants are trained to three-stems, keeping them in small pots as just described seems to be a disadvantage.

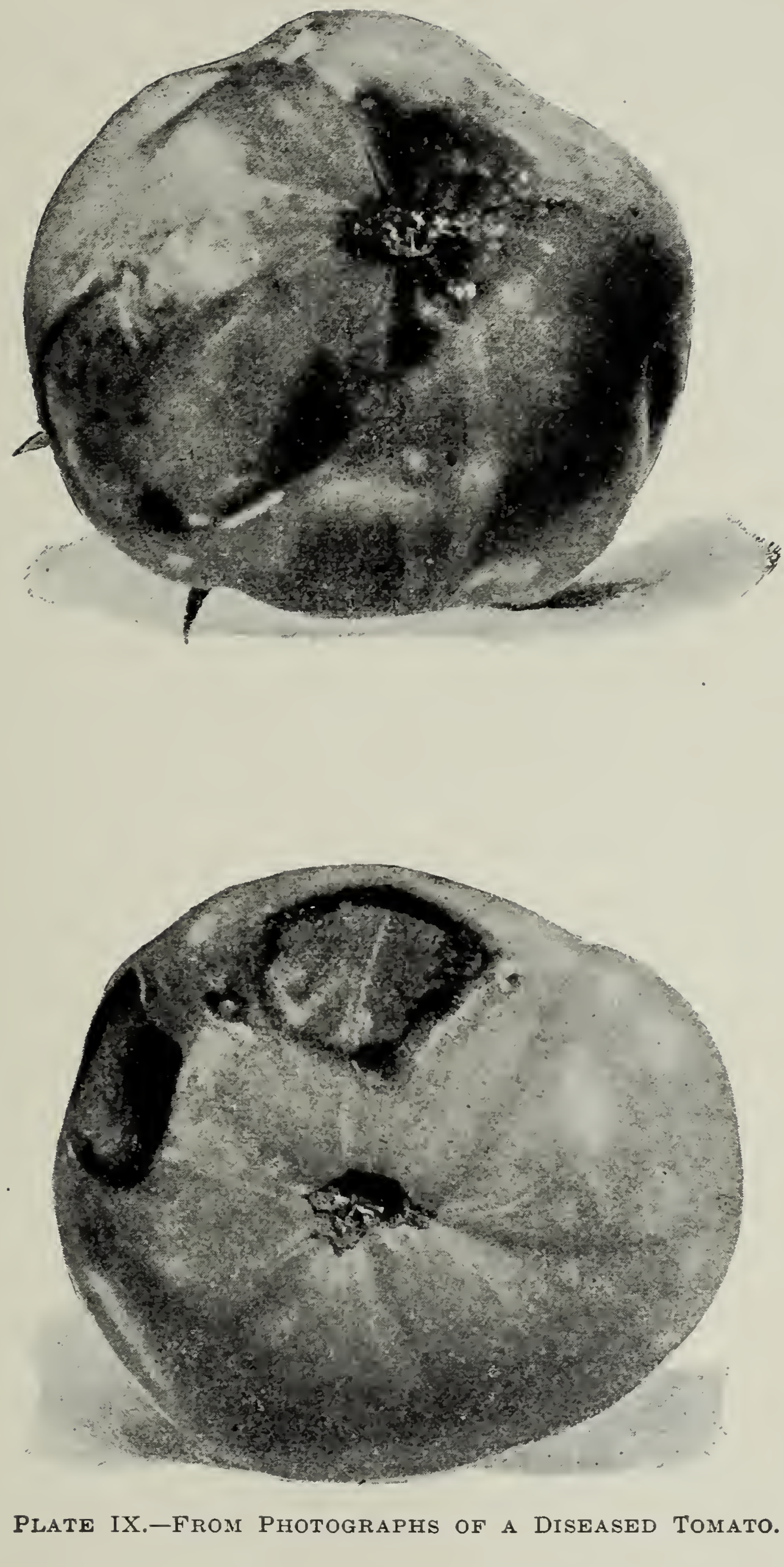


Plate IX.—From Photographs of a Diseased Tomato.

V. NOTE ON A TOMATO DISEASE.*

S. A. BEACH.

A peculiar disease of the tomato, the cause of which is not well understood, has occurred in the forcing house at this Station. Tomatoes which were attacked by what is apparently the same disease have also been found in other greenhouses. Specimens of the diseased fruit were furnished Mr. Stewart, the Station Mycologist, at Jamaica, N. Y., who has prepared from them the following description of the disease:

This disease has the general characters of the so-called black rot of field grown tomatoes, which attacks the blossom end of the early fruits and which is supposed to be caused by the fungus, *Macrosporium tomato*, Cke. It begins as a slightly depressed, circular, brown spot which gradually enlarges, retaining its circular form, until it frequently covers as much as one half of the entire surface of the tomato. See Plate IX. In the great majority of cases the spot originates at the blossom end of the fruit, but it may originate at any point on the fruit. In color, the spots are at first brown; later, they become brownish black or greenish black and are bounded by a conspicuous double ring of light brown. In texture, the diseased tissue is leathery and dry with the surface usually smooth and glassy but sometimes wrinkled and velvety. The diseased portion shrivels so much that the fruit becomes much flattened on that side. The boundary line between the healthy and diseased tissue is definitely marked. Inside, the tissues are blackened for a considerable distance below the surface and there is somewhat less than the normal amount of moisture.

It occurred most frequently on the early fruits of rapidly growing plants but continued to appear to some extent throughout the season. The fruits are attacked in all stages of development,

*Partial reprint of Bulletin No. 125.

but, as observed in the forcing houses at this Station, there are no indications that either the stem or the leaves are attacked by the disease.

The remarkable feature of this rot is the total absence of fungus hyphæ from the tissues of the fruits in the early stages of the disease. Neither is there, at this time, any species of bacterium very abundant. Micrococci in zoögloea may be frequently seen but not in large numbers. Old specimens often show species of Fusarium and Penicillium and various bacteria. Fragments of diseased tissue were taken, with sterilized instruments, from the interior of fruits recently attacked by the disease, and cultivated on neutral agar in Petri dishes. Nothing developed in any of these cultures. A Petri-dish culture on agar acidified with malic acid, likewise, gave negative results. If any organism is connected with this disease it is one which does not grow readily on agar.

VI. STRAWBERRIES IN 1897.*

WENDELL PADDOCK.

SUMMARY.

The Station has no more plants of the Hunn for distribution.

Of strawberries in one-year beds Beder Wood was the most productive early berry. It is also a satisfactory general purpose variety as it took second rank as to yield among the kinds that were fruited in one-year beds. Marshall is worthy of a trial for fancy fruit. Glen Mary was the most productive berry and produced the largest late yield.

None of the strawberries in two-year beds succeeded more than moderately well, owing no doubt, to winter injury and an unfavorable growing season. Earliest produced the largest early yield while Robinson was the most productive and gave the largest late yield.

INTRODUCTION.

The soil at the Station gardens is not well adapted to strawberry culture as it is composed of a stiff clay loam. Such soil is particularly hard to work in a wet season as some little time must elapse after each rain before the ground is in a condition to be worked. In the meantime weeds grow apace and if great care is not exercised to start the cultivator at the right time a crust soon forms and the soil becomes hard and compact. When such conditions arise the ground can only be gotten in good condition by cultivating at the proper time after another rain. The amount of rainfall at Geneva during a portion of the spring was rather large and considerable difficulty was experienced in keeping the soil in good tilth and in subduing the weeds.

The strawberries are grown in matted rows. As soon as the ground is lightly frozen in early winter the beds are mulched. Last winter coarse stable manure was used which had not become well rotted and which became more or less frozen before it

*Reprint of Bulletin No. 127.

was distributed over the beds. The result was that the plants were killed here and there in the rows in places where the frozen lumps chanced to fall.

The strawberry crop was not as satisfactory as could be desired owing in part to the conditions that have been described above. Not only were the yields of some varieties low but in many cases the berries were smaller in size than they should have been. These facts should be taken into consideration when the records of yields that are given in the following pages are consulted.

The blossoms of the strawberry are either pistillate, imperfectly staminate or staminate. The pistillate flowers are imperfect in their development in that they produce no pollen and are therefore incapable of setting fruit when planted by themselves. The imperfectly staminate flowers produce a small amount of pollen but not enough to enable them to set fruit satisfactorily; for our purpose varieties that have such flowers may be classed with the pistillate berries. The so-called staminate flowers are perfect in their development and so produce pollen. Accordingly varieties that have staminate flowers are able to set fruit when planted by themselves as well as to furnish a supply of pollen for the pistillate varieties. When pistillate varieties are planted it is very important that staminate varieties that blossom at the same time be planted with them. It is the custom with some growers to put a staminate variety in every third or fourth place in the row with the pistillate kinds. It is no doubt a better plan to plant every third row to a staminate variety as this arrangement admits of the different varieties being picked separately. Insects may be depended on to distribute the pollen.

In the description of varieties the letter P following the name of a variety indicates that it bears pistillate blossoms and needs to be planted near staminate kinds. The staminate varieties are indicated by the letter S following the name.

Of the newer varieties only a few were fruited on the station grounds this season. These have been described in full. Others of the more common kinds have been briefly mentioned; more complete descriptions may be had by consulting former bulletins and reports of this Station. In all cases where the name of the person from whom a certain variety was obtained is not given it is to be presumed that plants can be obtained of or through any

reliable dealer. The varieties that fruited in one-year-old beds are discussed first after which the kinds that were grown in two-year beds are considered.

NOTES ON VARIETIES.

THE HUNN STRAWBERRY.

As we still receive requests for plants of the Hunn strawberry it seems desirable to state that the Station has no more plants of this or other varieties of strawberries for distribution.

Before deciding to name and disseminate the variety it was thought best to test it in another portion of the State. Accordingly plants were sent to Mr. W. D. Barns, Middle Hope, N. Y. In the season of 1896 Mr. Barns was able to market some of the fruit, when it proved to be a very satisfactory late market berry. His report was published in Bulletin No. 109 of this Station. In the season of 1897 the variety was even more satisfactory. Concerning it Mr. Barns writes: "It is a matter of congratulation that under peculiarly unfavorable circumstances it has shown itself the most valuable strawberry we have."

Plants of the Hunn were first sent out by the Station in the fall of 1895 and a second distribution was made in the spring of 1897. Persons who secured plants when the first distribution was made should have quite a stock of plants by this time, therefore, if the variety succeeds it will soon become quite common. Under the terms of the contract entered into with Mr. Barns he will be at liberty to dispose of plants in the spring of 1898.

It is too much to expect that any one variety of strawberry will succeed equally well in all locations. In fact the force of evidence and trend of opinion point to the conclusion that certain varieties will be restricted more and more to special localities. If then the Hunn succeeds in a comparatively few sections of the State we will feel that it has not been a mistake to disseminate the variety.

VARIETIES IN ONE-YEAR-OLD BEDS.

Beauty, P. *From J. H. Haynes, Delphi, Ind.* Berry medium size, attractive scarlet color, good quality, moderately productive. Blossoms with Beder Wood.

Beder Wood, S. A productive, early berry of medium size and good quality. Succeeds where many varieties fail.

Canada Wilson, S. *From Birdseye and Son, Hopewell, N. Y.* Very similar to the old Wilson.

Clarence, S. (*Thompson No. 101.*) *From Thompson's Sons, Rio Vista, Va.* Fruit above medium, scarlet color, good quality. Moderately productive.

Columbian, S. *From W. F. Allen, Salisbury, Md.* Fruit medium or below in size. Unproductive in this locality.

Eleanor, S. *From Thompson's Sons, Rio Vista, Va.* Fruit medium or above, good color and quality. Not very productive, but worthy of a trial on account of its earliness.

Enormous. P. *From Thompson's Sons, Rio Vista, Va.* Blossoms with Beder Wood. Fruit large to very large, bright scarlet color, good quality. Ranks fourth in productiveness among varieties that were fruited in one-year-old beds. Worthy of a trial on account of size, color and productiveness.

Gandy, S. Well known in many localities as a profitable late variety. It does not succeed in some locations.

Giant, S. *From W. Y. Velie, Marlboro, N. Y.* Plants vigorous and productive of large fruits. The berries are soft and of a light color, therefore the variety cannot be recommended as a market berry.

Glen Mary, S. *From W. F. Allen, Salisbury, Md.* Sharpless type. Foliage healthy, leaves large with tall leaf stalks, runners moderately abundant, fruit-stems long, prostrate. Fruit large to very large, rather irregular in shape, good scarlet color. The most productive variety that fruited on the Station grounds in 1897. Recommended for trial on account of health, vigor and productiveness of the plants and the size and appearance of the berries.

Greenville, P. A satisfactory berry in many localities. Sharpless type. Blossoms with Sharpless.

Haverland, P. A standard variety. Fruits large, long conic, showy scarlet color.

Hersey, S. *From S. Hersey, Hingham, Mass.* Fruit small to medium, light scarlet color, firm, fair quality. Unproductive this season.

Hull No. 3, S. *From E. J. Hull, Olyphant, Pa.* Fruit large, light scarlet color, moderately firm, moderately productive.

Maple Bank, P. *From E. B. Stevenson, Lowville, Canada.* Blossoms with Sharpless. Fruit medium size, scarlet color, firm. Not productive this season.

Marshall, S. Does not succeed in many localities; where it does well it is very satisfactory. Fruit of largest size, dark scarlet color, good quality, firm. Recommended for trial where the best of culture can be given.

Mary, P. Plants strong but make few runners. Fruit very large but irregular and rough, moderately productive. Blossoms with Sharpless.

Michel, S. First early, fruit medium size, unproductive. Of value where very early fruit is desired.

Middlefield, P. A good variety for home use; has been only moderately productive on our grounds. Blossoms with Sharpless.

Murray, P. *From Thompson's Sons, Rio Vista, Va.* Fruit medium to large, dark scarlet color. Unproductive on our soil. Blossoms with Beder Wood.

Omega, P. *From Thompson's Sons, Rio Vista, Va.* Moderately productive. Fruit large, light scarlet color. Blossoms with Sharpless.

Robinson, S. *From Thompson's Sons, Rio Vista, Va.* Fruit medium to large, scarlet color, good quality. Ranks fifth in productiveness this season among varieties that were fruited in one-year-old beds.

Thompson, S. (*Lady Thompson.*) Has proven a failure on our soil. Fruit medium size, light scarlet color, unproductive.

Thompson No. 100, S. *From Thompson's Sons, Rio Vista, Va.* Fruit medium size, good, scarlet color. Unproductive this season.

Vera, P. *From E. B. Stevenson, Lowville, Ontario, Canada.* Foliage moderately vigorous, runners abundant, fruit stems

medium, prostrate. Fruit medium size, conical, scarlet color, moderately firm, quality good. Ranks seventh in productiveness among varieties that were fruited in one-year-old beds. Blossoms with Sharpless.

Williams, S. *From Ellwanger & Barry, Rochester, N. Y.* Fruit medium to large, rather soft, fair in quality, moderately productive.

TABLE I. — LIST OF STRAWBERRIES FRUITED IN ONE-YEAR-OLD BEDS, WITH A COMPARATIVE STATEMENT OF THE EARLY AND LATE YIELD OF EACH VARIETY.

Rank as to yield, 1897.	NAME OF VARIETY.	Yield of 66 square feet.	Per cent of crop picked before June 25.	Per cent of crop picked after July 5.
		Ounces.		
1	Glen Mary	544½	1	26
2	Beder Wood	401	22	17
3	Haverland	238	5	15
4	Enormous	240	15	8
5	Robinson	227½	00	28
6	Vera	217½	21	6
7	Beauty	212½	00	63
8	Canada Wilson	208½	9	13
9	Omega	204½	00	19
10	Giant	191	00	53
11	Williams	188½	00	21
12	Marshall	184½	20	9
13	Clarence	182½	00	31
14	*Hull No.* 3	178	00	25
15	Greenville	172	00	7
16	Sherman	158	00	13
17	Mary	157	00	20
18	*Thompson No.* 100	150	8	12
19	Gandy	148	00	42
20	Eleanor	135	27	4
21	Thompson *Lady Thompson*	127	11	23
22	Sharpless	123	00	10
23	Murray	122½	21	3
24	Hersey	122	00	6
25	Maple Bank	118	00	10
26	Middlefield	104	00	10
27	Columbian	102	00	12
28	Michel	80	58	00

EARLY VARIETIES IN ONE-YEAR-OLD BEDS.

The date of the beginning of mid-season of strawberries in this locality for the season of 1897 may properly be assumed to be June 25. By referring to Table I we find that six varieties yielded

a fifth or more of their crop before this date. These varieties may be called early for this season. They are given below in Table II.

Table II.—Early Varieties Ranked According to Yield Before June 25.

Name of variety.	Date of first picking.	Yield before July 5.	Total yield, 1897.	Rank as to total yield, 1897.
		Ounces.	Ounces.	
Beder Wood	June 21	88	401	2
Michel	June 16	46	80	28
Vera	June 16	45	217½	6
Marshall	June 21	36	184½	12
Eleanor	June 18	36	135	20
Murray	June 21	25	122½	23

Beder Wood has proven to be reliable here in either one, two or three-year-old beds. It can be strongly recommended as a general purpose berry. While it is ranked among the early varieties, it has a long fruiting period, as the last berries were picked on July 9. Michel is of value only when very early berries are desirable. Vera does not appear to possess special merit. Marshall is fickle in its behavior and requires high culture. Where it succeeds it is one of the best of the fancy berries. It usually ranks with the mid-season varieties. Eleanor and Murray are no improvement on better known sorts.

Late Varieties in One-year-old Beds.

July 5 may be regarded as the close of mid-season. Table I shows that eight varieties ripened a fourth or more of their crop after this date. These varieties may be called late for this season. They are given below in Table III.

Table III.—Late Varieties Ranked According to Yield After July 5.

Name of variety.	Date of last picking.	Yield after July 5.	Total yield, 1897.	Rank as to total yield.
		Ounces.	Ounces.	
Glen Mary	July 13	142	544½	1
Beauty	July 9	135	212½	7
Giant	July 13	101	191	10
Robinson	July 9	64	227½	5
Clarence	July 9	57	182½	13
Gandy	July 13	52	148	19
Hull No. 3	July 9	44	175	14

Glen Mary was the most productive variety on our grounds this season. This fact together with its large per cent of late yield, its large fruit and vigorous, healthy foliage will recommend it for further trial. Beauty is only moderately productive but of excellent quality. Giant is of large size and moderately productive but of light color and soft. Gandy is the standard late variety in many sections. It does not succeed in all localities. Robinson is fairly productive. The berries are of medium size and good quality. Clarence and *Hull No. 3* are no improvement on better known varieties.

VARIETIES IN TWO-YEAR-OLD BEDS.

TABLE No. IV—LIST OF STRAWBERRIES FRUITED IN TWO-YEAR-OLD BEDS, WITH A COMPARATIVE STATEMENT OF THE EARLY AND LATE YIELD OF EACH VARIETY.

Rank as to yield, 1897.	NAME OF VARIETY.	Yield of 66 square feet.	Per cent picked before June 25.	Per cent picked after July 5.
		Ounces.		
1	Robinson	286	0	40
2	*See No.* 4	214	0	18
3	Omega	200	0	32
4	Thompson	199½	13	17
5	Bissell	187	15	24
6	Enormous	175	20	17
7	*See No.* 5	162	5	4
8	*Slaymaker No.* 9	161	16	22
9	*See No.* 3	185	4	6
10	Tubbs	148	19	15
11	Clarence	147	0	24
12	Parker Earle	134	0	15
13	*Hull No.* 3	127	0	14
14	William Belt	124	0	23
15	Staples	101	39	1
16	Mary	100	0	38
17	Earliest	97	75	5
18	Murray	95	19	19
19	Maple Bank	93	4	5
20	Beecher	83	00	7
21	Hersey	83	18	12
22	Eleanor	72	25	8
23	Margaret	72	36	7
24	*Thompson No.* 100	66	35	12
25	Canada Wilson	52	19	14
26	Columbian	46	0	17
27	*Slaymaker No.* 8	35	22	8
28	Allen	34½	0	9

EARLY VARIETIES IN TWO-YEAR-OLD BEDS.

Again assuming that June 25th was the beginning of mid-season for this locality, Table IV shows that six varieties ripened more than a fourth of their crop before this date. These varieties may be called early for this season.

TABLE V.—EARLY VARIETIES FRUITED IN TWO-YEAR-OLD BEDS RANKED ACCORDING TO YIELD BEFORE JUNE 25.

NAME OF VARIETY.	Date of first picking.	Yield before June 25.	Total yield, 1897.	Rank as to total yield, 1897.
		Ounces.	Ounces.	
Earliest	June 16	73	97	17
Staples	June 16	40	102	15
Margaret	June 21	26	72	23
Thompson No. 100	June 21	23	66	24
Eleanor	June 18	18	72	22
Slaymaker No. 8	June 23	7	35	27

Earliest closely resembles Michel of which it is a seedling. Staples did not do well in a two-year-old bed as the plants lacked vigor; but it is worthy of a trial as an early sort. Margaret is not adapted to our stiff soil as the plants have not done well in either one or two-year-old beds. *Thompson No. 100* was unsatisfactory in a two-year-old bed as were also Eleanor and *Slaymaker No. 8.* A part of the failure of the varieties in two-year-old beds was no doubt due to winter injury as has been explained above.

LATE VARIETIES IN TWO-YEAR-OLD BEDS.

Table IV shows that seven varieties yielded over a fourth of their crop after July 5th, therefore these may be called late for this season.

TABLE VI.—LATE VARIETIES FRUITED IN TWO-YEAR-OLD BEDS RANKED ACCORDING TO YIELD AFTER JULY 5.

NAME OF VARIETY.	Date of last picking.	Yield after July 5.	Total yield, 1897.	Rank as to total yield, 1897.
		Ounces.	Ounces.	
Robinson	July 9	114	286	1
Omega	July 7	14	200	3
Bissel	July 9	45	187	5
Mary	July 9	38	100	16
Slaymaker No. 9	July 6	35	161	8
Clarence (*Thompson No.* 101)	July 9	33	147	11
William Belt	July 9	29	124	14

Robinson, Omega, Mary and Clarence have been mentioned under varieties that fruited in one-year-old beds. Bissel stood first in productiveness among varieties that fruited in one-year-old beds in 1896. This season it takes fifth place in productiveness among varieties that were fruited in two-year-beds. The fruit is medium size, good color and moderately firm.

Slaymaker No. 9, from Slaymaker & Son, Dover, Del., bears fruit large in size but rather light in color and low in quality. It is no improvement over known sorts.

William Belt received favorable mention last season. This season it takes a low rank because of the severe winter injury that the plants sustained.

LIST OF STRAWBERRIES RECEIVED IN 1897.

Babcock No. 4. From D. W. Babcock, Cromwell, Conn.

Bismark. From L. J. Farmer, Pulaski, N. Y.

Bouncer. From L. J. Farmer, Pulaski, N. Y.

Bryant. From Birdseye & Son, Hopewell, N. Y.

Bubach Seedling. From W. E. Doxie, Wappinger Falls, N. Y.

Carrie. From L. J. Farmer, Pulaski, N. Y.

Clyde. From L. J. Farmer, Pulaski, N. Y.

Cumberland Triumph Seedling. From W. E. Doxie, Wappinger Falls, N. Y.

Evans. From Slaymaker & Son, Dover, Del.

Fred. Stahelin. From F. C. Stahelin, Bridgman, Mich.

Gertrude. From W. F. Allen, Salisbury, Md.

Hall Favorite. From L. J. Farmer, Pulaski, N. Y.

Holland. From L. J. Farmer, Pulaski, N. Y.

Isabella. From J. H. Hale, South Glastonbury, Conn.

Jersey Market. From L. J. Farmer, Pulaski, N. Y.

Leader. From J. H. Hale, South Glastonbury, Conn.

Lovett Seedling. From W. E. Doxie, Wappinger Falls, N. Y.

Michigan. From L. J. Farmer, Pulaski, N. Y.

More Favorite. From C. J. More, Jamestown, N. Y.

Morgan No. 1. From J. A. Morgan, Scottsville, N. Y.

Noland. From J. P. Noland, Peninsula, Ohio.

Ocean City. From Slaymaker & Son, Dover, Del.

Ridgeway. From L. J. Farmer, Pulaski, N. Y.

Rural Gem. From J. H. Pease & Son, Thompsonville, Conn.

Sample. From C. S. Pratt, Reading, Mass.

Seaford. From L. J. Farmer, Pulaski, N. Y.

Stenger No. 1. From B. F. Stenger, Charlottsville, Ind.

Stenger No. 2. From B. F. Stenger, Charlottsville, Ind.

Tennyson. From Harrison's Nurseries, Berlin, Md.

VII. VARIETY TESTS WITH RASPBERRIES, BLACKBERRIES AND DEWBERRIES.*

WENDELL PADDOCK.

SUMMARY.

Poscharsky No. 15 takes first rank among black raspberries both as to total yield and the amount of fruit produced early in the season. Palmer has a long season as it is classed with both early and late berries. *Babcock No. 5* and Mills were the two most productive late berries.

Of red raspberries, Pomona gave the largest early yield and ranks second in productiveness. Cline ripens most of the crop in a few days and, as is usual with very early berries, is unproductive. Kenyon and Olathe were the most satisfactory late red raspberries. Of the mid-season varieties Loudon, Cuthbert and King deserve special mention.

Shaffer and Columbian are as yet the two standard varieties of purple raspberries.

Of blackberries, Dorchester, Success, New Rochelle and Stone Hardy were the most productive in 1897. Dorchester and New Rochelle have not always been hardy here. Early King produced the largest early yield.

Lucretia is as yet the only dewberry of importance in this section.

INTRODUCTION.

The stiff clay loam of the Station gardens is not well adapted to small fruit culture, but raspberries and blackberries succeed much better than strawberries. Early in the season the ground between the rows was plowed to a depth of about three inches with a one-horse plow. This effectually loosened the surface soil as could be seen by comparison with adjacent land that had not been plowed. The influence of the plowing could be noticed as long as cultivation was continued. After plowing the ground

*Reprint of Bulletin No. 128.

was smoothed with the cultivator and an endeavor was made to keep the soil from becoming compact by giving frequent cultivation.

Nearly all varieties came through the winter in good condition and set a full crop of fruit. The dewberries alone received winter protection which was given them by throwing a few shovelfuls of earth on the prostrate vines. Abundant rains when the fruit was ripening brought all the berries to maturity and thus it happens that some of the varieties that have not usually done well on our grounds make a good showing in the following tables.

Descriptive notes are given of some of the newer kinds and the older sorts have in some cases been briefly mentioned. In all cases where the source from which the plants were obtained is not given it is supposed that such varieties may be had of any reliable dealer.

BLACK RASPBERRIES.

NOTES ON VARIETIES.

Babcock No. 3. From D. W. Babcock, Cromwell, Conn. An attractive, large berry but only moderately productive on our soil.

Babcock No. 5. From D. W. Babcock, Cromwell, Conn. While the fruit is not quite as large as No. 3, it has been much more productive. It takes second rank this season. Both of the Babcock seedlings make a good showing among the late varieties as may be seen by consulting Table I. For this reason both are considered worthy of testing.

Black Diamond. *From C. W. Stewart, Newark, N. Y.* Fruit large with medium grains, good black color, firm, good quality and will evidently be productive. Its season is about with Gregg. A promising variety.

Eureka. A standard variety in many localities. It has a long season which extends from medium early to medium late.

Hopkins. *From A. M. Purdy, Palmyra, N. Y.* An early berry of large size but only moderately productive here.

Lawrence. *From A. H. Griesa, Lawrence, Kansas.* Fruit very large, moderately firm, good color and quality; evidently productive. Season a little later than Eureka. Worthy of further testing.

Mills. *From C. Mills, Fairmount, N. Y.* This variety has been favorably reported on in former reports of this Station. The fruit is of medium size and good quality. It stands third in productiveness this season.

Onondaga. *From C. Mills, Fairmount, N. Y.* Fruit large, attractive, good quality. It was only moderately productive this season.

Palmer. *From C. Mills, Fairmount, N. Y.* A standard variety in many places.

Progress. *From D. B. Garvin & Son, Wheeling, W. Va.* Berries medium size, good black color and moderately firm. It ranks fourth in productiveness this season.

Poscharsky Seedlings. From F. W. Poscharsky, Princeton, Ill. Neither *No. 3* nor *No. 9* are any improvement over better known sorts. *No. 15* ranks first in productiveness and in the amount of fruit produced early. The fruit is medium to large, firm, somewhat seedy, sweet and of very good quality. Where very early berries are desired this variety will be worthy of a trial.

Townsend No. 2. From G. Townsend, Gordon, O. Fruit medium to large, very good quality. It ranks sixth in productiveness this season.

TABLE NO. I.— LIST OF BLACK RASPBERRIES FRUITED IN 1897 WITH A COMPARATIVE STATEMENT OF THE PERCENTAGE OF EARLY AND LATE YIELD OF EACH VARIETY.

Rank as to yield, 1897.	NAME OF VARIETY.	When set.	Yield of row 25 feet long.	Per cent of crop picked before July 17.	Per cent of crop picked after July 23.	Per cent of canes winter killed.
			Ounces.			
1	*Poscharsky No.* 15	1894	466	42	11	5
2	*Babcock No.* 5	1894	419	3	35	10
3	Mills	1894	409	0	33	5
4	Pioneer	1894	401	24	26	3
5	Eureka	1894	390	22	24	3
6	*Townsend No.* 2	1894	359	10	16	5
7	*Babcock No.* 3	1894	335	0	33	0
8	Palmer	1894	285	28	31	3
8	*Poscharsky No.* 3	1894	285	35	15	5
9	Onondaga	1894	247	3	33	10
10	Hopkins	1894	216	32	20	10
11	*Poscharsky No.* 9	1894	186	37	18	5

Early Black Raspberries.

The mid-season of black raspberries for 1897 may be regarded as extending from July 17 to July 23. Those varieties that ripened a fourth or more of their crop before July 17 may be called early for this season. Table I shows five such varieties. These are arranged below in Table II.

Table II.—Early Black Raspberries Arranged According to Their Yield Before July 17.

Name of variety.	Date of first picking.	Yield before July 17.	Total yield.	Rank as to total yield.
		Ounces.	Ounces.	
Poscharsky No. 15	July 8	193	466	1
Poscharsky No. 3	July 8	100	285	8
Palmer	July 8	80	285	8
Hopkins	July 13	69	216	10
Poscharsky No. 9	July 8	69	186	11

Poscharsky No. 15 has made a good record this season. It is remarkable in that it gives the largest total yield as well as the largest early yield. *Poscharsky Nos. 3* and *9* are no improvement on better known sorts. Palmer is a well known early variety. Hopkins bears fruit of good size but is not productive enough on our soil to compare favorably with better known sorts.

Late Black Raspberries.

Assuming that mid-season ended on July 23 all varieties that ripened a fourth or more of their crop after this date may be called late for this season. Table I shows six such varieties. These are arranged below in the order of their yield after July 23.

Table III.—Late Black Raspberries Arranged According to Their Yield After July 23.

Name of variety.	Date of last picking.	Yield after July 23.	Total yield.	Rank as to total yield.
		Ounces.	Ounces.	
Babcock No. 5	July 30	147	419	2
Mills	Aug. 4	135	409	3
Babcock No. 3	Aug. 4	110	335	7
Pioneer	July 30	104	401	4
Palmer	July 30	88	285	8
Onondaga	Aug. 2	82	247	9

Babcock No. 5 and Mills can safely be recommended for trial. Palmer and Onondaga have not usually been as productive on our soil as they have elsewhere. However they are standard varieties in some localities.

RED RASPBERRIES.

TABLE IV. — LIST OF RED RASPBERRIES FRUITED IN 1897, WITH A COMPARATIVE STATEMENT OF THE PERCENTAGE OF EARLY AND LATE YIELDS OF EACH VARIETY.

Rank as to yield 1897.	NAME OF VARIETY.	When set.	Yield of matted row 25 feet long.	Per cent of crop picked before July 16.	Per cent of crop picked after July 26	Per cent of canes winter killed.
			Ounces.			
1	Loudon	1894	503	7	22	0
2	Pomona	1892	495	30	9	0
3	Cuthbert	1892	478	0	22	3
4	King	1894	471	15	13	0
5	Kenyon	1894	463	5	27	0
6	I. X. L.	1894	441	21	20	0
7	Pride of Kent	1893	401	19	11	3
8	Superb	1892	326	13	20	0
9	Royal Church	1892	322	4	20	5
10	Talbot	1894	306	10	26	0
11	Clarke	1894	288	10	16	0
12	Reder	1893	258	19	12	0
13	Olathe	1893	249	0	25	3
14	Turner	1892	233	20	9	3
15	Reliance	1893	228	16	18	5
16	Miller Woodland	1892	211	8	28	5
17	Cline	1893	180	62	2	1
18	Naomi	1893	179	15	20	10
19	Pride	1893	157	37	6	1
20	Superlative	1894	152	40	4	5
21	Brandywine	1892	146	2	30	5
22	Harris	1893	145	30	15	10

EARLY RED RASPBERRIES.

Assuming that mid-season of red raspberries began on July 16 those varieties that ripened a fourth or more of their crops before this date may be called early for this season. Table IV shows that there were six in this class. They are given below in Table V.

TABLE V.—EARLY RED RASPBERRIES ARRANGED ACCORDING TO THEIR YIELD BEFORE JULY 16.

NAME OF VARIETY.	Date of first picking.	Yield before July 16.	Total yield.	Rank as to total yield.
		Ounces.	Ounces.	
Pomona	July 7	148	495	2
Cline	July 6	111	180	17
Superlative	July 8	61	152	20
Pride	July 7	58	157	19
Harris	July 10	43	145	22

Pomona, from Wm. Parry, Parry, N. J., has always been satisfactory on our grounds. It is not only early but productive as well, ranking second in yield in 1897 among all the varieties. Cline, from G. W. Cline, Winona, Ont., is very early and yields most of its fruit in a few days after beginning to ripen. Pomona was much more satisfactory as its early yield was not only larger but it has a long season as well. Superlative, from Ellwanger & Barry, Rochester, N. Y., has berries of the largest size and Idaeus type.

LATE RED RASPBERRIES.

Again referring to Table IV we find that five varieties produced a fourth or more of their crop after July 26. These are given below in Table VI as late varieties.

TABLE VI.—LATE RED RASPBERRIES ARRANGED ACCORDING TO THEIR YIELD AFTER JULY 23.

NAME OF VARIETY.	Date of last picking.	Yield after July 26.	Total yield.	Rank as to total yield.
		Ounces.	Ounces.	
Kenyon	August 9	125	463	5
Talbot	August 7	78	306	10
Olathe	August 7	60	249	14
Miller Woodland	August 9	59	211	17
Brandywine	August 2	44	146	22

Kenyon, from A. M. Kenyon, McGregor, Ia., has fruit of medium size, moderately firm, rather dark when fully ripe and only fair in quality. It ranks fifth in yield this season and produced the largest precentage of late yield of any variety. Of the other berries included in the list of late varieties Olathe, from Stayman & Black, Lawrence, Kan., has been the most satisfactory.

MID SEASON VARIETIES.

Loudon, from C. A. Green, Rochester, N. Y., ranks first in yield this season among the red raspberries. It has a long fruiting season and gives a good late yield, though the percentage of late yield is not as large as some others. The fruit resembles the Marlboro; the plants are vigorous and have been perfectly hardy here thus far. Cuthbert is one of the standard red raspberries and is perhaps more grown than any other red variety. It is not firm enough to ship long distances.

King, from Cleveland Nursery Co., Rio Vista, Va., bears fruit of large, fine, bright color, firm, good quality; plants vigorous and hardy. It ranks fourth in productiveness among all the red raspberries that fruited this season.

PURPLE RASPBERRIES.

TABLE VII.—LIST OF PURPLE RASPBERRIES FRUITED IN 1897, WITH A COMPARATIVE STATEMENT OF THE PERCENTAGE OF EARLY AND LATE YIELD OF EACH VARIETY.

Rank as to yield, 1897.	NAME OF VARIETY.	When set.	Yield of row 25 feet long.	Per cent of crop picked before July 16.	Per cent of crop picked after July 26.	Per cent of canes winter-killed.
			Ounces.			
1	Smith Purple	1895	481	20	16	3
2	Shaffer	1895	414	0	27	25
3	Addison	1894	382	50	1	5
4	Columbian	1894	376	0	30	3
5	Teletaugh	1895	376	14	4	......
6	Beckwith	1894	195	0	51	3
7	Redfield	1895	123	0	26	3

By referring to the above table it will be seen that only one variety, Addison, gave a large percentage of early yield. This berry is not worth growing in this locality as the berries are small and crumble badly.

Smith Purple, from B. F. Smith, Lawrence, Kan., was the most productive. This variety has all of the characteristics of the black raspberries aside from its purple color.

Shaffer and Columbian have been the most satisfactory purple berries. There seems to be but little difference in productiveness between the two.

Teletaugh, from J. F. Street, West Middletown, Ind., is a new comer and has not been sufficiently tested to decide as to its merits. The berries are large, dark purple with an abundance of bloom that gives them a mouldy appearance. The fruit is firm and rather tart. Its season is somewhat earlier than Shaffer or Columbian.

BLACKBERRIES.

TABLE VIII.—YIELD OF BLACKBERRIES IN 1897.

Rank as to yield, 1897.	NAME OF VARIETY.	When set.	Yield of row 25 feet long.	In marketable condition.	Per cent of canes winter-killed.
			Ounces.		
1	Dorchester	1893	755	July 26 to Sept. 2	0
2	Success	1892	606	July 30 to Sept. 7	0
3	New Rochelle	1893	589	July 26 to Sept. 2	0
4	Stone Hardy	1893	588	Aug. 9 to Sept. 2	0
5	Early Mammoth	1892	528	July 28 to Aug. 30	0
6	Agawam	1893	467	July 28 to Aug. 30	0
7	Erie	1893	443	July 30 to Aug. 7	3
8	Western Triumph	1895	438	Aug. 2 to Aug. 30	0
9	*Ford No.* 1	1892	408	Aug. 7 to Sept. 7	0
10	Woodland	1892	371	July 30 to Sept. 2	0
11	Ancient Briton	1893	352	Aug. 2 to Aug. 30	0
12	Early King	1892	330	July 30 to Sept. 7	0
13	Lovett	1893	317	Aug. 7 to Aug. 30	0
14	Wilson, Jr.	1893	211	July 23 to Aug. 30	5
15	Sandford	1894	195	Aug. 9 to Aug. 30	0
16	Black Chief	1893	187	Aug. 7 to Sept. 7	0
17	Early Harvest	1895	170	July 15 to Aug. 17	0
18	Child Tree	1894	122	July 26 to Aug. 21	3
19	Fruitland	1892	71	Aug. 12 to Aug. 30	0

Most of the blackberries came through the winter uninjured by the cold. On this account some of the varieties take a high rank in yield that have not heretofore been productive here.

Dorchester is a well known old variety. It has not always been hardy here.

Success, from L. W. Carr and Co., Erie, Pa., received favorable notice in our report for 1896 and this season it takes second rank in yield. The berries are of medium size with medium grains and small core; quality good.

New Rochelle (*Lawton*), is a well known old sort. It is one of the finest of blackberries when grown at its best but the plants are not hardy enough to be reliable in this locality.

Stone Hardy ranked second in yield last season and takes fourth place this year. The fruit is of medium size and good quality.

Early Mammoth, from Cleveland Nursery Co., Rio Vista, Va., is said to be a hybrid between the blackberry and dewberry. The fruit varies from the largest size to small, imperfect berries. The plants are not usually hardy here.

Agawam is a well known variety. The plants are quite hardy in this locality. The fruit is of medium size and good quality.

Erie is an old variety. It has not been as productive here as some others.

Ancient Briton took first rank in yield last year which may account in part for its low place this season. This has been regarded as one of the most reliable varieties. The fruit is of medium size.

Early King, from Ellwanger & Barry gave the largest early yield and its total yield was satisfactory for such an early sort. The canes are of medium size and the plants are vigorous. Fruit medium size, good quality.

Wilson Jr. belongs in the same class with Early Mammoth and resembles that variety in bush and fruit. They both need winter protection in this locality.

Early Harvest has been quite satisfactory in former years as an extra early variety. Last season fully established plants took third rank as to yield. The berries are of medium size and good quality.

DEWBERRIES.

TABLE IX.—YIELD OF DEWBERRIES IN 1897.

Rank as to yield, 1897.	NAME OF VARIETY.	Yield of row of 20 feet long.	In marketable condition.
		Ounces.	
1	Lucretia	198	July 17 to Aug. 12
2	Bartel	102	July 15 to Aug. 2
3	Austin Improved	68	July 17 to Aug. 2
4	Mammoth	38	July 15 to July 30

So far as tested here Lucretia is the only satisfactory dewberry. Austin Improved did not come up to our expectations this season. The berries were imperfect and sour.

LIST OF RASPBERRIES RECEIVED IN 1897.

Bishop. From B. F. Smith, Lawrence, Kansas.
Cumberland. From D. Miller, Camp Hill, Pa.
Egyptian. From B. F. Smith, Lawrence, Kansas.
Great American. From J. L. Childs, Floral Park, N. Y.
Highland Hardy. From S. D. Willard, Geneva, N. Y.
Munger. From W. N. Scarff, New Carlisle, Ohio.
New Cardinal. From A. H. Griesa, Lawrence, Kansas.
Perpetual King. From C. J. More, Jamestown, N. Y.

LIST OF BLACKBERRIES RECEIVED IN 1897.

Clark. From M. Crawford, Cuyahoga Falls, Ohio.
Rathbun. From Fred E. Young, Rochester, N. Y.

VIII. RESULTS WITH OAT SMUT IN 1897.*

C. P. CLOSE.

SUMMARY.

In the experiments conducted by the author in 1897 Ceres powder, lysol, formalin and potassium sulphide were compared with the Jensen hot water treatment for the prevention of oat smut.

Sprinkling the seed with a 1 per cent solution either of lysol or formalin entirely prevented smut. The seed which was sprinkled with solution of potassium sulphide varying in strength from 1 per cent to 5 per cent gave from 0.6 per cent to 1 per cent of smutted heads. Ceres powder used in the same strength was even less effective, as the seed treated with it gave from 1 per cent to 2.9 per cent of smutted heads.

In the experiments in soaking seed, the treatments which entirely prevented smut are: 0.3 per cent lysol, seed soaked 1 hour; 0.2 per cent formalin, seed soaked 1 hour; 2 per cent potassium sulphide, seed soaked 1.5 hours; and 4 per cent Ceres powder, seed soaked 0.5 hour.

The hot water treatment kept the crop wholly free from smut.

None of the above treatments injured the seed.

For sprinkling one bushel of seed one gallon of the solution is required. A gallon of 1 per cent solution of lysol costs 5 cents. The same amount of 1 per cent formalin solution will cost 4 cents.

In soaking a bushel of oats one hour about one and four-fifths gallons of solution will be absorbed. This amount of 0.3 per cent lysol solution will cost 2.7 cents, a like amount of 0.2 per cent formalin solution will cost 1.4 cents, of 2 per cent potassium sulphide 5.4 cents and of 4 per cent Ceres powder 39.6 cents.

---

*Reprint of Bulletin No. 131.

Lysol sells for about 65 cents per pint; formalin for about 50 cents per pint; potassium sulphide for 18 cents per pound; and Ceres powder in bottles of 2.2 lbs for $1.50.

The Jensen hot water treatment consists in soaking the seed for a given time in water at a certain temperature, 133° for 10 minutes being usually recommended.

Sprinkling is done by applying the solution with a sprinkling pot and shoveling the pile over until all the seed is saturated.

Smut is a parasitic plant which grows inside of the stalks of oats. The black masses which appear in the heads of oats are the spores, or seeds, by which the smut is propagated.

Oats attacked by smut are usually dwarfed, and often weakened so much that many stalks never head out.

The following table shows cost per bushel of seed for chemicals in the least expensive successful treatments.

COST OF CHEMICALS FOR PREVENTION OF OAT SMUT.

MATERIAL.	SPRINKLING.		SOAKING.		
	Strength of solution.	Cost per bushel.	Strength of solution.	Length of time.	Cost per bushel.
	Per cent.	Cents.	Per cent.	Hours.	Cents.
Lysol	1	5	0.3	1	2.7
Formalin	1	4	0.2	1	1.4
Potassium sulphide	......	......	2.	1.5	5.4
Ceres powder	......	......	4.	0.5	39.6

The cost of material per acre for treating seed with the 0.2 per cent formalin solution is 3½ cents, allowing two and one-half bushels of seed per acre. Sprinkling with solutions of lysol or formalin weaker than 1 per cent was not tried, but they may prove effective in preventing smut.

INTRODUCTION.

The results of some investigations in 1897 in treating seed oats for the prevention of smut are presented in this Bulletin.

The hot-water treatment, which originated with Prof. Jensen, is one of the most effective remedies for preventing oat smut, but since it involves heating the water and keeping it at a certain

temperature for a given time, many have the idea that the operation is too complicated, therefore the remedy has not come into general use.

Soaking or sprinkling the seed with some solution may be considered a simpler process, and should it prove to be equally as effective, would probably become popular more rapidly than the hot-water treatment. Prof. Jensen has lately been advocating a remedy, Ceres powder, to be used in this way. This substance is reported as giving excellent results in some parts of Europe, and has received favorable mention in this country by Kellerman.* A bureau has been opened in Chicago to advertise Ceres powder and push its sale. Since this remedy is thus being brought to public notice in this country it was decided to test it here and to compare it with other remedies for oat smut. The other remedies which were tried were hot water, formalin, potassium sulphide and lysol.

So far as known to the writer, lysol has not before been used as a preventive of smut. In these experiments, as will be shown later, it has given excellent results. Formalin† and potassium sulphide† have been tried before with varying success, according to the strengths used.

In order to give the different remedies a thorough test, some of the treatments which were tried on the Station farm were duplicated on larger areas under different environment in another part of the State. The details of the work will accordingly be considered under two heads: (1) Experiments at the Station and (2) experiments at Trumansburg.

EXPERIMENTS AT THE STATION.

A piece of ground that would give conditions as nearly uniform as possible was selected for this purpose. This was divided into plats twenty feet long, each of which contained three rows, one foot of space between the rows and one and one-half feet

*Report of Society for the Promotion of Agricultural Science, 1896; p. 64.

†Bolley, H. L., N. Dak. Exp. Sta. Bul. No. 27, Kellerman, W. A., Proceedings of the Society for the Promotion of Agricultural Science, 1896; Kellerman, W. A., Kan. Exp. Sta. Bul. No. 22; Wheeler, C. F., Mich. Institute Bul. No. 3; Year Book U. S. Dept. Agr., 1896, p. 259.

between the plats. Untreated plats were distributed so as to form checks for each series of from three to six treated plats. Four rows of untreated seed were sown at each end of the piece so as to make the conditions of light, etc., of the end plats as nearly like those of the center plats as possible.

SEEDING OF PLATS.

Owing to heavy rains the seeding could not be done until May 22 to 26, three weeks after the seed was treated. An equal amount of seed was sown in each row. The seed oats used were selected because of the abundance of smut they contained. This fact gave assurance that the untreated seed used for checks would produce at least an average amount of smut which could be used as a basis of comparison for the treated plats.

CHEMICALS USED AND KIND OF TREATMENT.

Plats were sown with seed which had been *sprinkled* with 1, 2, 3, 4, 5 and 6 per cent solutions of lysol, 1, 2 and 3 per cent solutions of formalin, and with 1, 2, 3, 4 and 5 per cent solutions of potassium sulphide and of Ceres powder. Other plats were seeded with oats which had been *soaked* for 1, 2 and 3 hours in solutions containing 1 part in 1,000 of lysol and of formalin, for 1 and 2 hours in 2 to 1,000 solutions and for 1 hour in solutions of these same substances containing 3, 4, 5 and 6 parts in 1,000; while the seed treated with potassium sulphide and Ceres powder was soaked for 0.5, 1 and 1.5 hours in solutions of these materials containing 20 and 40 parts in 1,000.

GERMINATION, GROWTH AND PERCENTAGES OF SMUTTED HEADS.

No attempt was made to compare the yield of the different plats, because the seeding was done so late in the spring that the short growth and small heads were unsatisfactory for this purpose. The percentage of smutted heads was determined by counting the stalks. This was done at the time of harvesting, August 16 to 20. The different treatments, with their respective germinations of seed, growth of plants and percentages of smutted heads are given in the following table. The untreated plats are considered normal in germination and growth.

RESULTS OF TREATMENT OF SEED OATS BY SPRINKLING WITH FUNGICIDES.

MATERIAL.	Strength of solution.	Smutted heads.	Remarks.
	Per cent.	Per cent.	
Lysol	1	0	Germination and growth normal.
Lysol	2	0	Germination and growth normal.
Lysol	3	0	About two-thirds of the seed grew; it was slow in germinating but the plants made a taller and more stocky growth, were very rusty, and much later in maturing than where the seed was treated with less lysol.
Lysol	4	0	Less than one-fourth of the seed grew and that gave plants like the next above.
Lysol	5	0	About one-twentieth of the seed grew. It gave plants like those in the 3 per cent treatment.
Lysol	6	0	Only a few seeds grew; the plants were like those in the 3 per cent treatment.
Untreated	....	10	
Formalin	1	0	Germination and growth normal.
Formalin	2	0	Very few seeds grew and two-thirds of these did not produce heads.
Formalin	3	0	Even fewer seeds grew than in the one next above and one-fourth of these did not produce heads.
Untreated	....	8.7	
Potassium sulphide	1	0.7	Germination and growth normal.
Potassium sulphide	2	0.8	Germination and growth normal.
Potassium sulphide	3	0.9	Germination and growth normal.
Potassium sulphide	4	1.0	Germination and growth normal.
Potassium sulphide	5	0.6	Germination and growth normal.
Untreated	....	6.4	
Ceres powder	1	2.9	Germination and growth normal.
Ceres powder	2	1.5	Germination and growth normal.
Ceres powder	3	2.7	Germination and growth normal.
Ceres powder	4	1.0	Germination and growth normal.
Ceres powder	5	1.3	Germination and growth normal.
Untreated	....	6.4	Germination and growth normal.

RESULTS OF TREATMENT OF SEED OATS BY SOAKING IN FUNGICIDES.

MATERIAL.	Strength of solution.	Length of time.	Smutted heads.	Remarks.
	Parts in 1000.	*Hours.*	*Per cent.*	
Lysol	1	1	3.7	Germination and growth normal.
Lysol	2	1	1.3	Germination and growth normal.
Lysol	3	1	0	Germination and growth normal.
Lysol	4	1	0	Germination and growth normal.
Lysol	5	1	0	Germination and growth normal.
Lysol	6	1	0	Germination and growth normal.
Untreated	....	......	8	
Lysol	1	2	5.3	Germination and growth normal.
Lysol	1	3	3.3	Germination and growth normal.
Lysol	2	2	0.7	Germination and growth normal.
Formalin	1	2	0.3	Germination and growth normal.
Formalin	1	3	0.3	Germination and growth normal.
Formalin	2	2	0	Germination and growth normal.
Untreated	....	......	4.7	Germination and growth normal.
Formalin	1	1	0.2	Germination and growth normal.
Formalin	2	1	0	Germination and growth normal.
Formalin	3	1	0	Germination and growth normal.
Formalin	4	1	0	Germination and growth normal.
Formalin	5	1	0	Germination and growth normal.
Formalin	6	1	0	Germination and growth normal.
Untreated	....	......	5.4	
Potassium sulphide*	20	0.5	0.1	About 25 per cent of seed failed to grow; plants made normal growth.
Potassium sulphide	20	1.5	0	Germination and growth normal.
Potassium sulphide	40	0.5	0	Germination and growth normal.
Potassium sulphide	40	1	0	Germination and growth normal.
Potassium sulphide	40	1.5	0	Germination and growth normal.
Untreated	....	......	1.5	
Ceres powder	20	0.5	0.5	About 20 per cent of seed failed to grow; plants made normal growth.
Ceres powder	20	1	0.4	About 20 per cent of seed failed to grow; plants made normal growth
Ceres powder	20	1.5	0.2	Germination and growth normal.
Untreated	....	......	1.5	Germination and growth normal.
Ceres powder	40	0.5	0	Germination and growth normal.
Ceres powder	40	1	0	Germination and growth normal.
Ceres powder	40	1.5	0.1	Germination and growth normal.
Untreated	....	......	8.7	

*Record for plat from seed soaked one hour in potassium sulphide was lost.

WHAT THE ABOVE RESULTS SHOW.

With lysol.—The 1 per cent and 2 per cent solutions sprinkled did not injure the seed and entirely prevented smut. The 3 per cent solution sprinkled injured the seed so that one-third of it did not germinate, while the plants from the other two-thirds were stocky, very late in maturing and very rusty. Solutions stronger than 3 per cent injured the seed more in proportion to their increased strengths.

Soaking the seed for 1 hour with from 3 to 6 parts per 1,000 prevented the growth of smut, while untreated seed gave 8 to 10 per cent of smutted heads. When the seed was soaked in weaker solution, the smutted heads varied from 0.7 per cent to 5.3 per cent. None of the seed soaked in lysol solutions was injured.

With formalin.—The 1 per cent solution sprinkled on the seed was effective and did not injure the seed. The 2 per cent solution, sprinkled, killed about 95 per cent of the seed and the 3 per cent solution sprinkled killed even more than this. Two to six parts per 1,000 on seed soaked one hour, and 2 parts per 1,000 on seed soaked two hours killed all smut spores without injuring the seed. Weaker solutions gave from 0.3 per cent to 0.7 per cent of smut, while untreated seed gave from 4.7 per cent to 8.7 per cent of smut.

With potassium sulphide.—Seed sprinkled with from 1 per cent to 5 per cent solution was not injured, but gave from 0.6 per cent to 1 per cent of smut, while the untreated seed gave 6.4 per cent. That soaked in a 2 per cent solution for 1.5 hours and in the 4 per cent solution from 0.5 to 1.5 hours prevented smut and caused no injury to the seed.

With Ceres powder.—Seed treated by sprinkling with from 1 per cent to 5 per cent solutions gave from 1 per cent to 2.9 per cent of smutted heads, but was not injured; the untreated seed gave 6.4 per cent of smut. The 2 per cent treatments soaking 0.5 hour and 1 hour injured the seed about 20 per cent and gave 0.5 per cent, or less, of smutted heads. The seed soaked in a 2 per cent solution 1.5 hours gave 0.2 per cent smut; that soaked

in a 4 per cent solution 1.5 hours gave 0.1 per cent and was not injured. The 4 per cent treatments, where seed was soaked 0.5 hour and 1 hour, prevented smut without injuring the seed.

EXPERIMENTS AT TRUMANSBURG.

Since the experiments at the Station were of necessity conducted on small plats, it was deemed advisable to duplicate a few of them on a larger scale in a locality where the oat smut was abundant the previous season. Accordingly, arrangements were made with Messrs. King & Robinson, Trumansburg, Tompkins county, by which a plat of two-sevenths of an acre was used for each different treatment.

On April 13 the seed was treated by sprinkling in lots of one bushel as follows:

STRENGTH OF FUNGICIDE SPRINKLED ON OATS.

Material.	Strength of solution. Per cent.
Ceres powder *	0.78
Potassium sulphide	5
Potassium sulphide	3
Formalin	5
Formalin	3

METHOD OF TREATMENT.

The oats were placed on the barn floor in piles of one bushel each. The necessary amount of each chemical was put in one gallon of water and was applied with a sprinkling pot. By spreading the pile somewhat and alternately sprinkling and turning the oats, each bushel was thoroughly saturated and absorbed practically the whole gallon of the mixture. To dry them the piles were spread and shoveled over occasionally for two or three days.

SEEDING AND GROWTH.

The seed was drilled in April 21 at the rate of two and one-fourth bushels per acre. Three check or untreated plats were sown for the five treated plats. The seed treated with Ceres

*This strength is at the rate of one ounce in one gallon of water, practically as per directions of the manufacturers of Ceres powder, who recommended one ounce of the powder in one gallon of water sprinkled on 33⅓ pounds of seed.

powder and potassium sulphide germinated as well and made as good growth as the untreated seed did. The experiment with formalin was short and decisive. None of the seed germinated, thus proving that the 5 per cent and 3 per cent solutions were fatal to the seed. As soon as it was certain that this seed would not grow, another bushel was given the hot-water treatment and the plat seeded May 4, at the same rate per acre as before. This made a fairly good growth, but rusted badly, due, no doubt, to late sowing. At the time of harvesting, August 3, the grain of all the plats was flat upon the ground, having been broken down by heavy rain and wind storms. The yields were undoubtedly reduced a little by this condition, since lodged grain is difficult to harvest, but as all of the plats were in the same condition the yields are comparable.

PERCENTAGE OF SMUT AND YIELD OF PLATS.

The percentage of smutted heads was obtained by selecting representative parts of each plat and counting the stalks.

TREATMENT, PERCENTAGE OF SMUT AND YIELD PER ACRE OF OATS.

MATERIAL.	Strength of solution sprinkled.	Smutted heads.	Yield.
	Per cent.	Per cent.	Bushels.
Ceres powder	0.78	6.3	59.72
Potassium sulphide	5.0	0.85	57.64
Potassium sulphide	3.0	1.4	54.36
Hot water	....	0	54.58
Untreated	....	11.8	54.36

That the hot-water treatment did not give a larger yield is undoubtedly due to late sowing and to the rusting of the plants.

COMPARISON OF RESULTS.

At Trumansburg the seed sprinkled with a 0.78 per cent Ceres powder solution gave 6.3 per cent of smutted heads. The only experiment at the Station to compare with this is where seed was sprinkled with a 1 per cent solution and gave 2.9 per cent of smut. Seed sprinkled with a 5 per cent potassium sulphide solution at Trumansburg gave 0.85 per cent of smut,

while at the Station seed treated with the 5 per cent solution gave 0.6 per cent. With the 3 per cent potassium sulphide solution the result at Trumansburg is 1.4 per cent and at the Station 0.9 per cent of smutted heads. These results show a slight difference in favor of the work done at the Station. There was also less smut on the untreated plats at the Station, 10 per cent being the highest. At Trumansburg the untreated plats gave 11.8 per cent of smutted heads.

COST OF MATERIALS.

Lysol.—This material can be purchased in small quantities for about 65 cents per pound, or pint. In carboy lots it sells for about 30 cents per pound.

The 1 per cent treatment, sprinkled, will cost about 5 cents per bushel of seed.

In soaking the seed in a solution of 1 part in 1,000 the cost is 0.5 cent per gallon of the solution.

Formalin.—Formalin and the "40 per cent Solution of Formaldehyde Gas" are exactly the same material, but in purchasing it is well to ask for the latter, because it is quoted much lower in price than formalin.* The 40 per cent solution of formaldehyde gas sells for about 50 cents per pound, or pint, in small lots, and in carboy lots for about 30 cents per pound. The material for one gallon of the 1 per cent solution costs 4 cents. A gallon of the solution 1 part in 1,000 costs 0.4 cent.

Potassium sulphide may be obtained for about 18 cents per pound. A gallon of 1 per cent solution will cost a trifle less than 1.5 cents. The same amount of solution 1 part in 1,000 will cost less than 0.2 cent.

Ceres powder is put up in bottles holding one kilogram or 2.2 pounds. A single bottle sells for $1.50 and a lot of ten for $10. The rate per ounce for single bottle is about 4.25 cents. This is sufficient for one gallon of the solution necessary for sprinkling one bushel of seed as advocated by the manufacturers. A gallon of the 1 per cent solution requires 1.28 ounces and costs nearly 5.5 cents.

* De Schweinitz, E. A., Year Book U. S. Dept. Agr., 1896, p. 262.

The cost of material for the least expensive treatments which entirely prevented the smut is herewith given:

COST OF FUNGICIDES FOR PREVENTION OF OAT SMUT.

MATERIAL.	SPRINKLING.		SOAKING.		
	Strength of solution.	Cost per bushel.	Strength of solution.	Length of time.	Cost per bushel.
	Per cent.	Cents.	Per cent.	Hours.	Cents.
Lysol	1	5	0.3	1	2.7
Formalin	1	4	0.2	1	1.4
Potassium sulphide	.....	.....	2	1.5	5.4
Ceres powder	.....	.....	4	0.5	39.6

HOT WATER TREATMENT.

This treatment is really a very simple operation, but something about the thought of doing it seems formidable to many persons, and they hesitate to try it. The Station has recommended the following plan as easy, cheap and practical. Heat the water in a large kettle and near the kettle sink a barrel in the ground so the top will be a foot or more above the surface. Pour part of the hot water into the barrel and take the temperature with a good thermometer—be sure to have a *good* one—and add either cold or hot water until a temperature of 138° is reached. The dipping is done by putting about a bushel of oats in a course gunny sack, tying this to one end of a pole and resting the pole over a post, thus making a lever, by which the sack of oats may be raised or lowered very easily. When the oats are dipped into the water at 138° the temperature is immediately lowered and hot water must be added at once to keep the temperature about 133°. Keep the seed moving all the time and take out at the end of ten minutes. Spread the oats on a barn floor or other convenient place and shovel them over three times a day for a few days; then they may be sown with a force drill; or, when they are taken out of the hot water, pour cold water over them, spread them out to drain, and in two or three hours they may be sown broadcast. As the oats absorb considerable water it is

necessary to sow about half a bushel* more per acre than when untreated seed is used. This is on the basis of two and one-half bushels per acre. Two men in one day can treat enough seed to sow twenty acres.*

NOTES ON SMUT.

What Is It?

The so-called smut is a parasitic plant, that is, a plant which feeds upon some other plant as a host, and grows upon, or inside of it. It comes from a spore, which is comparable to a seed in the higher plants, grows and produces fruit, with which to perpetuate itself much the same as any other plant. The black masses of smut so noticeable when the grain is ripening consist of countless numbers of minute ripened spores, the fruit of the parasitic plant. These spores are often blown from the oat-head as soon as they ripen, thus leaving a naked stalk, but more often, perhaps, they remain in black disagreeable masses.

How the Smut Plant Grows.

Since the smut spores are microscopic in size a large number may be attached to the kernels without being noticed. In this way they are unavoidably sown with the oats in the spring. While the oats are germinating and growing the smut spores are doing the same thing, only in a little different way. Each germinating spore sends out a minute tube which penetrates the little oat plant when it is perhaps from two to four days old. After entering the oat plant the minute tube develops into branching threads, which grow up within the plant. There is no evidence of their presence until the heads are forming, but at this time the kernels of oats are filled with these branching threads which rob them of their nourishment and ripen myrids of new spores. Thus, what should have been a head of oats turns out to be a worse than worthless mass of dusty spores. It sometimes happens that only a part of the head or panicle is thus affected and the stalks from each stool may or may not all be attacked by the parasite.

*Holden, P. G., Mich. Exp. Station Bul. 87.

GROWTH OF SMUTTED OAT-PLANTS.

Since the smut parasite robs its host, the growing oat-plant, of much nourishment, the latter is naturally much weakened, and only a part of the smutted plants attain the average height of healthy ones. The others are dwarfed more or less and often to such an extent that they grow only a few inches high. A large number of diseased plants, especially those much dwarfed, are so weakened that they cannot push their panicles, or heads, out of the sheath of the upper leaf. Upon opening these closed heads they are found to be full of smut masses. Thus it is that the casual observer sees only the high smut and concludes that the crop is only slightly smutted.

INFECTION OF SEED OATS BY SMUT SPORES.

The seed is infected in several ways. Many of the spores ripen before the oats do, are blown about by the wind and become lodged on the ripening grain. In case the smut ripens early while some of the oats are still in bloom the spores are liable to become attached to the growing ovaries of the grain in such a position that the glume or husk of the individual oat kernels envelopes the spores, thus making it difficult to destroy them. The wholesale agent of infection is the threshing machine, and the crop from a field practically free from smut is liable to become infected by spores carried in the machine from an infected neighboring field. Then the use of sacks, grain bins, etc., that have held smutted grain helps to distribute the smut spores.

IX. SPRAYING IN 1897 TO PREVENT GOOSEBERRY MILDEW.*

C. P. CLOSE.

SUMMARY.

For ten years this Station has advocated potassium sulphide as the best remedy for gooseberry mildew.

In the season of 1897 potassium sulphide, Bordeaux mixture, lysol and formalin were tested side by side.

The plantation was divided into six sections. In two of these the spraying was begun very early, just as the buds were breaking; in two others eleven days latter; and in the remaining two sections twelve days after the preceding two sections.

The first mildew appeared May 26. By June 7 portions of the plantation were badly mildewed. At this date the lysol and formalin seemed to have done no good. Bordeaux mixture was more effective, but not so good as potassium sulphide where the treatments were begun very early and medium early.

All of the fruit was picked July 6 and 7 so as to market it green. Bushes sprayed very early with potassium sulphide at the rate of 1 oz. to 3 gals. of water gave only 5 per cent of mildewed fruit; those sprayed very early with it at the rate of 1 oz. to 2 gals. of water gave 6.6 per cent. Bushes sprayed very early with lysol, 1 oz. to 1 gal. of water, gave 24.5 per cent and those sprayed very early with Bordeaux mixture gave 37.4 per cent of mildewed fruit, while the untreated bushels gave 57.7 per cent to 78.7 per cent.

The foliage was not injured by any of the fungicides.

At 18 cents per pound for potassium sulphide, the cost of the solution which gave the best results is about one-fifth of one cent per bush for the seven sprayings.

*Reprint of Bulletin No. 133.

The Station recommends potassium sulphide, 1 oz. to 3 gals. or 1 oz. to 2 gals. of water, as the most effective fungicide for gooseberry mildew.

As a rule only the English varieties and their seedlings are attacked by mildew although the American varieties are not always exempt.

INTRODUCTION.

Potassium sulphide was first used as a remedy for the powdery mildews in Europe about 1884. In 1886 it was used to a very limited extent in this country. In the following year, 1887, this Station* made the first practical test of the efficiency of potassium sulphide in combating gooseberry mildew, and although the material was not applied until the mildew was well established, the results showed that there was a beneficial effect from its use. Since then its efficiency has been proven by successive tests† and it has been recommended by the Station as the best remedy for holding mildew in check.

After Bordeaux mixture came into general use some authorities‡ advocated it as a substitute for potassium sulphide early in the season, but so far as known to the writer, these recommendations were not based on comparative tests of the two fungicides. The only record of such a comparison which he finds is that of an undecisive test made at this Station in 1892. Accordingly, in 1897, experiments were planned so as to compare them side by side. For comparison with Bordeaux mixture and potassium sulphide two other fungicides, lysol and formalin, were tried. So far as the writer has been able to find out, lysol and formalin have never before been used for this purpose.

---

*Arthur. Sulphide of Potassium as a Fungicide. N. Y. Agl. Exp. Sta. Rept. 1887, pp. 348-350.

†Goff. Potassium Sulphide for Gooseberry Mildew. N. Y. Agl. Exp. Sta. Rept. 1888, pp. 153-154. Hunn. Gooseberries. N. Y. Agl. Exp. Sta. Rept. 1889, p. 334; 1890, p. 307; 1891, p. 474. Beach and Paddock. Gooseberry Mildew. N. Y. Agl. Exp. Sta. Rept. 1895, p. 354.

‡Lodeman. The Spraying of Plants, p. 292; and Spray Calendars, Cornell Univ. Agl. Exp. Sta., Feb., 1895, and Feb., 1896. Taft. Spray Calendar, Mich. Agl. Exp. Sta., Apr., 1894; Green, Selby and Webster. Spray Calendar, Supplement to Ohio Agl. Exp. Sta., Bul. 79. Spray Calendar, Md. Agl. Exp. Sta., Apr., 1896. Spray Calendar, Del. Agl. Exp. Sta., Apr., 1895. Craig [Canadian] Exptl. Farms Rept. 1895.

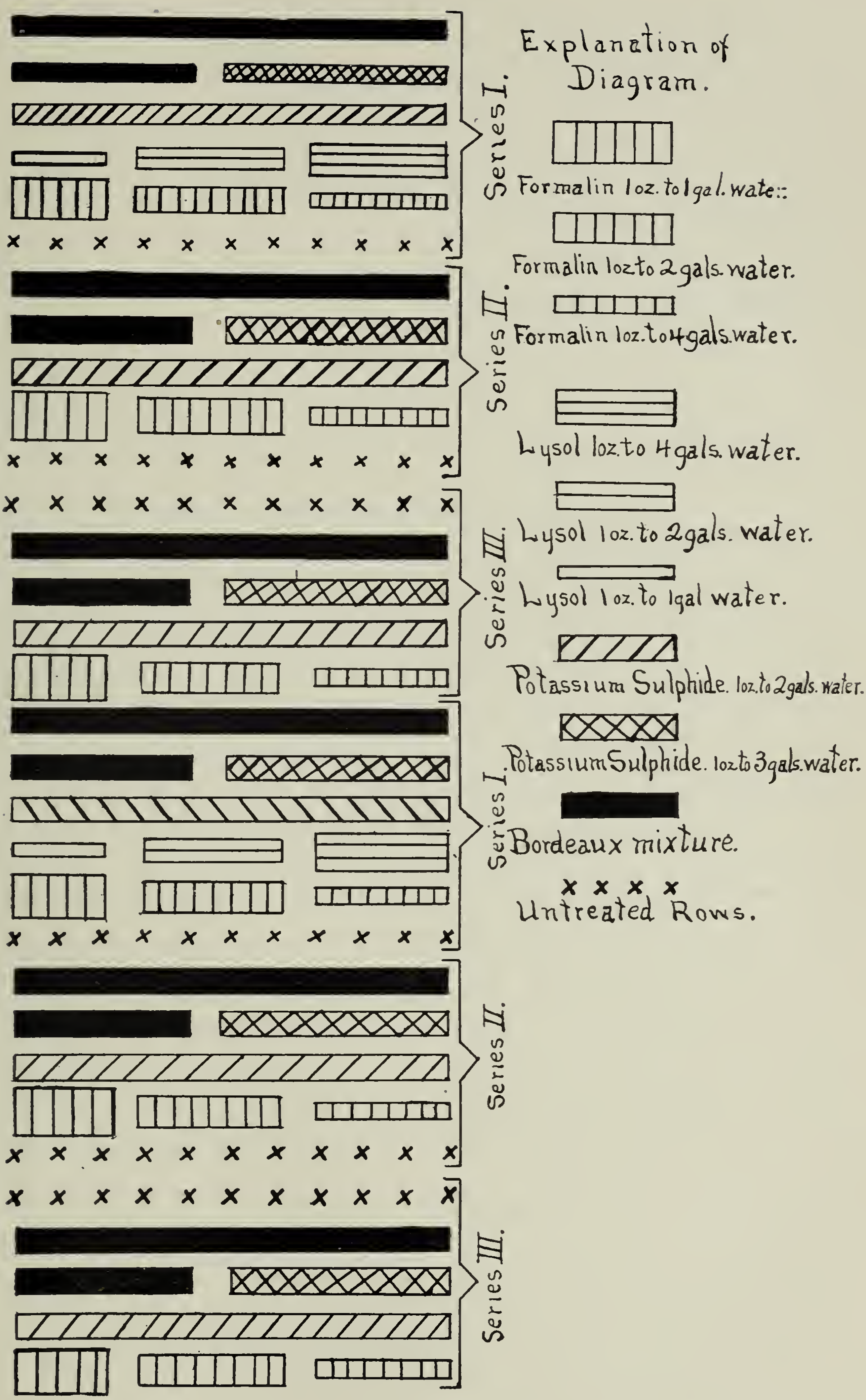


Diagram 1.—Gooseberry Plats for Mildew Treatment.

OBJECT AND PLAN OF THE EXPERIMENT.

Object.

The object of the experiment was to compare sprayings begun very early with those begun medium early and late. Bordeaux mixture and different strengths of formalin and lysol were also to be compared with different strengths of potassium sulphide.

Plan of Experiment.

The Industry plantation of King & Robinson, Trumansburg, N. Y., was used for the experiments. It consisted of 32 rows with 11 plants to the row. As shown by the diagram opposite, the plantation was divided into six plats. Each treatment was applied to two plats separated by plats receiving different applications. This arrangement was for the purpose of equalizing for each remedy the differences in soil and location which might exist in different parts of the plantation.

For convenience in comparing the effects of very early with medium and late spraying, three series of treatments were made. Series I was begun very early, April 12, just as the buds were breaking and successive applications were made at intervals of about ten days until seven had been given. Series II was begun April 23 when the second treatment of Series I was made. The first treatment of Series III was applied May 5 when the third treatment of Series I and the second treatment of Series II were given. During the remainder of the season the dates of treatment were the same for all applications. An untreated row was left as a check for each series.

Materials Used.

Bordeaux mixture, 1-to-11 formula, was used upon one set of bushes in each series until the fruit was large enough so that spotting with the mixture would injure its sale; then potassium sulphide, 1 oz. to 2 gals. of water, was substituted for the remainder of the season.

Potassium sulphide was used in two strengths, 1 oz. to 2 gals. of water and 1 oz. to 3 gals. of water.

Lysol and formalin were each used in three strengths, 1 oz. to 1 gal. of water, 1 oz. to 2 gals. and 1 oz. to 4 gals. These strengths were settled upon arbitrarily for trial since there were no previous experiments which might be followed as a guide.

The foliage was not injured by any of the solutions.

METHOD OF APPLICATION.

The first spraying was given with a knapsack sprayer, but this was inconvenient, especially where so many different solutions were used and the sprayer had to be washed out after each solution was applied. After the first application a bucket pump made by the Deming Co., Salem, Ohio, was tried and gave good satisfaction. With a seven-foot hose all parts of the plant could be readily reached.

DIVISION OF SERIES AND DATES OF SPRAYING.

The table opposite shows upon which rows the different strengths of fungicides were applied and gives the dates of application. The division into series is shown in the diagram opposite page 309.

RESULTS.

DEVELOPMENT OF MILDEW.

The plantation was closely watched for the first appearance of mildew and at the fifth spraying, May 26, a little was found on the fruit, especially on the untreated rows. On the treated rows there was a very slight difference in favor of the potassium sulphide treatments. All of the bushes had made a good, healthy growth and nearly all were loaded with fruit. At this time the berries were so large that potassium sulphide, 1 oz. to 2 gals. of water, was substituted for all Bordeaux mixture treatments so as to avoid having spotted fruits at the marketing season.

At the time of the sixth spraying, June 7, the entire plantation was examined to find out which treatments seemed to be most effective. During the few days previous to this date the disease appeared on the young leaves; and in the amount of mildew on the foliage there seemed to be no difference between the treated and untreated bushes. The fruit on the untreated bushes was

Table I. Division of Series and Dates of Spraying.

Bordeaux Mixture.	Potassium Sulphide		Lysol.			Formalin.		
1 to 11 formula.*	1 oz. to 3 gals.	1 oz. to 2 gals.	1 oz. to 1 gal.	1 oz. to 2 gals.	1 oz. to 4 gals.	1 oz. to 1 gal.	1 oz. to 2 gals.	1 oz. to 4 gals.
Series I. Very Early Treatment. Applications April 12, 23, May 5, 17, 26, June 7, 21.								
Row 1, and 5 bushes of row 2..........	Last 6 bushes of 2	Rows 3, 19	Bushes 1–3, row 4	Bushes 4–7, row 4	Bushes 8–11, row 4	Bushes 1–3, row 5	Bushes 4–7, row 5	Bushes 8–11, row 5
Row 17, and 5 bushes of row 18..........	Last 6 bushes of 18		1–3, row 20	4–7, row 20	8–11, row 20	1–3, row 21	4–7, row 21	8–11, row 21
Series II. Medium Early Treatment. Applications April 23, May 5, 17, 26, June 7, 21.								
Row 7, and 5 bushes of row 8..........	Last 6 bushes of 8	Rows 9, 25				Bushes 1–3, row 10	Bushes 4–7, row 10	Bushes 8–11, row 10
Row 23, and 5 bushes of row 24..........	Last 6 bushes of 24					1–3, row 26	4–7, row 26	8–11, row 26
Series III. Late Treatment. Applications May 5, 17, 26, June 7, 21.								
Row 13, and 5 bushes of row 14..........	Last 6 bushes of 14	Rows 15, 31				Bushes 1–3, row 16	Bushes 4–7, row 16	Bushes 8–11, row 16
Row 29, and 5 bushes of row 30..........	Last 6 bushes of 30					1–3, row 32	4–7, row 32	8–11, row 32

* Last three treatments in each series potassium sulphide, 1 oz. to 2 gals. water.

Note.—There were six check rows, numbers 6, 11, 12, 22, 27 and 28.

very badly mildewed. The treatments with lysol and formalin in some instances seemed to have slightly checked the mildew on the fruit. The combined treatment of Bordeaux mixture and potassium sulphide had checked the disease, but the most favorable results appeared where the potassium sulphide had been used for very early and medium early treatments.

PICKING THE FRUIT.

The last spraying was made June 21. Messrs. King & Robinson wished to market the fruit green, so on July 6 and 7 it was picked. The mildewed fruit and perfect fruit were weighed separately for each different treatment. In order to have an accurate basis of comparison the yields are figured so as to give the average per plant in each experiment. The results are so arranged in the following table that the reader can easily compare the same remedies in the different series. It must be borne in mind that Series I received seven sprayings beginning April 12, Series II received six sprayings beginning April 23, and Series III received five sprayings beginning May 5.

TABLE II.— AVERAGE YIELD AND PERCENTAGE OF MILDEW PER BUSH FOR EACH TREATMENT.

FUNGICIDE.	Series 1. Spraying begun very early. Seven applications.			Series 2. Spraying begun medium early. Six applications.			Series 3. Spraying begun late. Five applications.		
	Average yield per bush.		Mildewed fruit.	Average yield per bush.		Mildewed fruit.	Average yield per bush.		Mildewed fruit.
	Free.	Mildewed.		Free.	Mildewed.		Free.	Mildewed.	
	Ozs.	Ozs.	Per ct.	Ozs.	Ozs.	Per ct.	Ozs.	Ozs.	Per ct.
Bordeaux mixture:*									
1 to 11 formula	26.2	15.7	37.4	34.8	14.3	29.1	18.1	25	58
Potassium sulphide:									
1 oz. to 3 gallons water	76.8	4	5	45.3	8	15.1	70	10.5	13
1 oz. to 2 gallons water	56.2	4	6.6	42.6	6	12.3	38 5	5	11.5
Formalin:									
1 oz. to 1 gallon water	21	20	48.8	3.5	12.6	78.3	22	28	56
1 oz. to 2 gallons water	17	24.5	59.1	9	50	84.7	10	25	71.4
1 oz. to 4 gallons water	28.4	31.5	52.6	21	39	65	17.6	41 8	70.4
Checks	19.4	26.5	57.7	9	33.2	78.7	9	33.2	78.7
Lysol:									
1 oz. to 1 gallon water	37	12	24.5						
1 oz. to 2 gallons water	19	25	56 8						
1 oz. to 4 gallons water	44	26	37.1						
Check	19.4	26.5	57.7						

* Last three treatments in each series potassium sulphide, 1 oz. to 2 gals. water.

From a study of Table II we see that, with the exception of Bordeaux mixture, the very early treatments gave the best results. Where the treatment with potassium sulphide, 1 oz. to 3 gals. water, was begun very early only 5 per cent of the fruit mildewed. Where it was begun medium early there was three times as much mildewed fruit, while in the treatment begun late there was a little more than two and one-half times as much. The bushes treated very early with potassium sulphide, 1 oz. to 2 gals. water, yielded 6.6 per cent of mildewed fruit and those where the treatments was begun medium early and late gave nearly twice as much.

Lysol ranks next to potassium sulphide in effectiveness. It was used in Series I only and the bushes treated with 1 oz. to 1 gal. water gave 24.5 per cent of mildewed fruit; bushes treated with the weaker strengths gave 56.8 per cent and 37.1 per cent respectively of mildewed fruit.

The best result with Bordeaux mixture was where the sprayings were begun medium early and 29.1 per cent of the fruit mildewed. With the very early treatment 37.4 per cent of the fruit mildewed and where spraying was begun late 58 per cent of the fruit mildewed.

Formalin seemed to have little if any effect in checking the mildew. The bushes in Series I treated with 1 oz. to 1 gal. of water gave 48.8 per cent of mildewed fruit. The amount of mildewed fruit in the other experiments with formalin varied from 52.6 per cent to 78.3 per cent, while the largest amount from the untreated bushes was 78.7 per cent.

The average cost of the various fungicides is given in the table below.

Table III.—Average Cost of Fungicides.

Fungicide.	Per pound.	For One Gallon of Solution.			
		1 oz. to 1 gallon water.	1 oz. to 2 gallons water.	1 oz. to 3 gallons water.	1 to 11 formula.
	Cents.	Cents.	Cents.	Cents.	Cents.
Lysol	65	4.06	2.03	......	......
Formalin	50	3.125	1.56	......	......
Potassium sulphide	18	......	0.54	0.375	......
Bordeaux mixture	......	......	......	......	0.5

By formalin as used in this article is meant the 40 per cent solution of formaldehyde gas. When purchasing, it is well to ask for the 40 per cent solution of formaldehyde gas as it is quoted much lower than the same material under the name of formalin.*

RECOMMENDATION.

For holding the gooseberry mildew in check the Station recommends potassium sulphide as the most effective remedy. It may be applied at the rate of 1 oz. to 2 or 3 gals. of water beginning *very early* in the season, just as the buds are breaking, and repeating about every ten days, depending, of course, upon the condition of the weather.

GENERAL APPEARANCE OF MILDEW.

The mildew is a parasitic plant, or fungus, which appears on the surface of the fruit and young shoots. When first noticed it is composed of glistening, white threads which give it a frost-like appearance. As the fungus develops the threads become more numerous and matted, lose their glistening color and finally become a mass of brownish felt-like substance. It has now completed its growth and ripened its winter spores and can usually be peeled off the berries without rupturing the skin.

If the attack is severe the tender young leaves and shoots will be seriously injured, if not killed, and the growth checked. The growth of the berries will also be checked and they are likely to be misshapen and even to crack open thus letting in the germs of decay.

The spores by which the fungus is reproduced correspond to the seeds in higher plants but are very much simpler in construction. There are two kinds of spores, the summer spores and the winter spores. The summer spores (conidia) are formed on vertical branches of the glistening white threads which make up the fungus. As the vertical branch grows in length a partition appears near the upper end. This partition soon cuts off all connection with the lower part of the branch and the upper part

*De Schweinitz, E. A., Year Book U. S. Dept. of Agr., 1896, p. 262.

develops into a spore. While this spore is developing at the tip the branch is growing longer and the formation of new spores is begun in the same way lower down. As soon as the tip spore ripens it drops off, and as the branch is continually growing and forming new spores, there is a succession of ripe spores scattered broadcast to spread the disease. When these spores alight on the leaves or fruit with proper conditions of moisture and temperature present, growth immediately takes place; and since thousands of these spores are formed daily the disease is spread very rapidly.

The fertilization and development of the winter spores correspond to the fertilization and development of seeds of higher plants but are quite different and usually take place late in the season of growth of the fungus. In certain instances where two threads come near to or cross each other an enlargement or cell forms on each, one partaking of the functions of the male organs and the other of the female organs of a flower. At a certain stage of the development protoplasm passes from the male cell to the female cell and the latter is thus fertilized. Growth immediately begins and by the time the fungus assumes a brownish color black specks may be seen upon it; these specks are the winter spore cases (perithecia). Within the dark covering of the winter spore case will be found an inner spore case (ascus) which contains eight of the winter spores. In this double covering of spore cases the winter spores live over winter. By spring the cases break open and the spores escape. They are blown about by the wind and when they reach the leaves or fruit of the gooseberry bush under favorable conditions growth takes place and the pest is started for the season.

As a rule only the English varieties and their seedlings are attacked by mildew, although the American varieties are not always exempt. A comparison of the susceptibility to mildew of the English varieties as grown at this Station is given in Bulletin No. 114.

X. WOOD ASHES AND APPLE SCAB.*

S. A. BEACH.

SUMMARY.

In an experiment including 124 trees in full bearing and continued for five years, liberal applications of hard-wood ashes did not increase the immunity of apples from the scab. With few exceptions, the varieties on treated sections yielded larger percentages of scabbed fruit than those on untreated sections.

On the treated sections of the orchard the foliage in many cases was improved, but it cannot be said that the improvement was due to increased immunity from the scab.

Where the ashes were used, the color of the fruit was much improved in some seasons with some varieties, but in a season which favored the perfect development of the fruit none of the varieties showed any improvement in color as compared with the same varieties on untreated sections.

Apparently the use of ashes had a general tendency to hasten the perfect development of the fruit. When the season was not especially favorable to the perfect development of the fruit, it improved the keeping quality, but in a season very favorable to the perfect development of the fruit the ripening processes were generally carried so far where the ashes were used that the apples did not keep so well as where no ashes were used.

The yield, except with the Baldwins, was greater on the treated sections; but the data are not such as make it safe to draw definite conclusions as to the effect of the use of ashes on the yield.

Decided differences were shown between varieties as to the ability to resist scab, and preliminary investigations indicate that this difference in resistant power is correlated with structural peculiarities.

*Reprint of Bulletin No. 140.

INTRODUCTION.

The apple stands first in importance among the cultivated fruits of New York. Within the borders of this State no other fruit is so largely grown for home use and none equals it in commercial importance. It is more or less subject to injury both in foliage and fruit by a disease commonly known as the scab*, which is caused by a parasitic fungus, *Fusicladium dendriticum* (Wallr.) Fckl. Some kinds of apples are usually quite subject to injury from the scab while others generally suffer but slightly from its attacks. Among the varieties which are naturally susceptible to the disease are Fameuse or Snow, Fall Pippin, Primate and White Winter Pearmain. Among those which are resistant to the disease in a marked degree are Ben Davis, Black Gilliflower, Grimes Golden, Hubbardston, Maiden Blush, Talman and Yellow Transparent. It is certain that local conditions influence the spread of the disease because the same variety is injured more by it in some localities than in others. Moist locations offer conditions which favor its development.

It is well known that the amount of injury from the scab varies with the season. Continued dark, wet, cool weather at blooming time and immediately thereafter favors the growth and spread of the fungus and may bring about such an outbreak of the scab as to cause the destruction of large numbers of forming fruits, thus greatly diminishing the crop. Under such conditions of light, moisture and temperature the young foliage and fruit are abnormally developed and become unusually susceptible to the attacks of the fungus, while these very conditions favor, or at least are not unfavorable, to the healthy growth of the fungus.

From what has been said in the preceding paragraphs it appears that the amount of injury which is caused by the scab fungus

*This disease, as it occurs on the fruit, is so well known that it is unnecessary to give an extended description of it here. In very severe attacks it forms great brown patches which crack open, disfigure the fruit and render it unfit for market. The injured spots vary in size from such as these down to minute dots which easily pass unnoticed. On the leaves the fungus forms olive-brown patches varying in size as on the fruit. The spots occur on either the upper or under surface and often cause the leaf to become crumpled. The diseased tissue may finally crack and fall away, thus giving the leaves a ragged appearance.

varies according to the natural susceptibility of the variety to its attacks; that with any given variety it varies in different localities and in different seasons, and that the conditions of light, temperature and moisture, especially when the fruit it setting, have much to do with the prevalence of the disease.

So far as known to the writer, it has never been shown that the composition of the soil influences in any perceptible degree the susceptibility of the foliage and fruit to attack of the scab except as it affects the amount of moisture. Whether the ability of the foliage and fruit to resist the scab may be increased by the application of a certain class of fertilizers to the soil, or whether by the use of certain other kinds of fertilizers the liability to injury from this disease may be increased, are questions which have perplexed the minds of thoughtful fruit growers. Joseph Harris brought up this question in a paper on fertilizers at the 1891 meeting of the Western New York Horticultural Society.* He said: "I cannot but think that anything calculated to increase the growth, vigor and luxuriance of the trees will render them less liable to injury from fungous diseases. If this is true then fertilizers will help us."

In a discussion in the same society† in 1893 the idea was advanced that trees may be fed so as to fit them to resist fungi; that too liberal use of highly nitrogenous fertilizers, such as stable manure, fosters conditions which render the trees more liable to injury from fungous diseases, and that such tendencies may be corrected by the use of plant food containing more potash and phosphoric acid. Some were inclined to think that the application of hard-wood ashes to the soil increased the ability of the tree to resist the scab. In order to discover whether liberal applications of hard-wood ashes to the soil would have any perceptible influence on the immunity of the foliage and fruit from the scab fungus, an investigation was started at this Station in 1893 which has continued to the present time. The results are here offered as a contribution to our knowledge on this subject.

*Proc. W. N. Y. Hort. Soc., Rochester, 1891, p. 100.
†Proc. W. N. Y. Hort. Soc., Rochester, 1893, pp. 19, 140, 141.

PLAN AND CONDITIONS OF THE EXPERIMENT.

PLAN.

In any orchard the amount of injury from scab is liable to vary considerably with different trees of the same variety in the same season. It may also vary greatly with the same tree in different seasons, being influenced by the conditions of light, temperature and moisture. The investigation was planned on an extensive scale, so that the peculiar environment of individual trees and the varying influences of different seasons might not lead to erroneous conclusions. Some sections of the orchard in which the experiment was conducted were annually fertilized with liberal applications of wood ashes and corresponding sections received no ashes. As many trees of a kind as possible were included in each of the two classes, the treated and the untreated, and the experiment has continued five years. Fortunately for the experiment, the scab was unusually abundant one season, 1894, and did an enormous amount of injury to apple foliage and fruit throughout the State. The period of the experiment also covers the seasons of 1895 and 1896 in which the climatic conditions were generally favorable to the production of foliage and fruit free from the scab.

To guard against the possibility of having the test ruined by insects, the orchard was sprayed each year with arsenites and the insects were thus kept under control, excepting plant lice. No fungicides were used.* Since all sections were treated alike the spraying did not lessen the value of the records for comparing sections which were treated with ashes with corresponding untreated sections. The trees were annually pruned for the purpose of removing weak or dead branches and keeping the tops open so that spraying could be done readily. The fruit was not thinned, because more scabby fruit might thus be taken from treated than from untreated sections or *vice versa.*

*The insecticides which were used were London purple, Scheele's green and Paris green. Lodeman has shown that Paris green has slight fungicidal value. Cornell Exp. Sta. Bull. 48, pp. 272-273. In his tests London purple showed no fungicidal value. Cornell Exp. Sta. Bull. 86, p. 60.

Under the conditions which have been described above it is clear that the effect of the variation in the amount of scab on trees of the same variety in different locations, and on the same tree in different seasons, may be largely corrected by averaging the results of a large number of trees for a period of several years. The results which are set forth on the following pages, therefore, form a reliable basis for conclusions as to the influence which the use of wood ashes as a soil fertilizer may have on the immunity of apples from the scab fungus so far as the particular soil is concerned on which this experiment was made. The extent to which such conclusions may be accepted for other localities must be determined by further observations. It is believed that they will hold true generally except possibly in localities where the soil is notably deficient in potash.

An old apple orchard belonging to the Station was selected for this investigation in the spring of 1893. It is located about a mile and a half west of Seneca Lake, mostly on upland, but extending at one side down a short southern slope and including a small portion of Castle Creek bottom land. The soil is a rather heavy clay loam, quite well adapted to the apple, but not equal in this respect to the best apple lands of western New York.

The oldest trees were planted in 1850, making them forty-three years planted when the experiment was begun. They were root-grafted trees from the nursery of T. C. Maxwell & Bros., Geneva, N. Y. Nearly half of the trees which were first planted are gone and their places are now filled with trees varying in size from those recently planted to mature trees which have been in full bearing for many years. The orchard does not form as uniform a block of trees as could be desired for the experiment, but it is readily accessible and under the Station's control. Taking all things into consideration, it was the best one available for the investigation.

Prior to 1893, the year the experiment was inaugurated, the orchard had been in meadow for several years. During the winter of 1892-3 it was given a heavy application of stable manure

and the following spring it was plowed. Since then it has either been used for soiling crops or has been given clean cultivation till about August 1 and then seeded to some cover crop.

THE APPLICATION OF WOOD ASHES TO TREATED SECTIONS.

The orchard was divided into eight sections, four of which have had an annual application of wood ashes at the rate of one hundred pounds per tree, and the remaining four sections have received none. No other fertilizer has been applied to any part of the orchard during the experiment except within two or three feet of trees which have been newly planted to fill vacancies. The ashes have been weighed separately for each tree and spread broadcast to the line midway between adjacent rows. They were thoroughly mixed and carefully sampled before being spread in the orchard. The analyses given herewith show the percentage of potash in each application.

First application	4.13 per cent, K_2O
Second "	3.89 " "
Third "	5.71 " "
Fourth "	5.71 " "
Fifth "	1.38 " "

Since one hundred pounds of ashes were applied to each tree annually the above figures show the number of pounds of potash per tree in each application. The trees are thirty feet apart each way making forty-eight trees per acre. The amount of actual potash which has been applied to the treated sections during the five years is 20.82 pounds per tree or 999.36 pounds per acre, an average of 200 pounds per acre annually. The amount of potash commonly recommended for apple orchards varies from 50 to 100 pounds per acre annually. The amount of potash which was applied in this experiment is exceedingly liberal, being twice as great as the highest amount commonly recommended for apple orchards.

The amount of phosphoric acid in the ashes which were used in this experiment was not determined. Dr. Van Slyke* states that the amount of phosphoric acid in wood ashes varies from

*N. Y. Agl. Exp. Sta. Bull. 94, p. 323.

1 to 2 per cent. At the lower estimate one pound of phosphoric acid per tree was applied each year in this experiment, or 48 pounds per acre. The application of from 30 to 60 pounds of available phosphoric acid per acre is commonly recommended for apple orchards. The phosphoric acid in the ashes is mostly insoluble and becomes available slowly. It may possibly become available as readily as the phosphoric acid of coarsely powdered bone.

EXPLANATION OF DIAGRAM.

Baldwin, treated, Nos. 10, 101, 102, 108, 109, 125, 126, 127, 128.

Baldwin, untreated, Nos. 81, 111, 133, 136, 137, 207.

Fall Pippin, treated, Nos. 31, 33, 34, 35, 37, 38, 39.

Fall Pippin, untreated, Nos. 1, 4, 5, 6, 8, 9.

R. I. Greening, treated, Nos. 50, 51, 52, 54, 55, 56, 58, 70, 105, 107, 129, 146.

R. I. Greening, untreated, Nos. 24, 25, 26, 27, 28, 29, 42, 43, 46, 48, 62, 69, 82, 83, 162, 165, 184, 185.

Roxbury Russet, treated, Nos. 143, 145, 147, 149.

Roxbury Russet, untreated, Nos. 150, 153, 161, 175.

Northern Spy, treated, Nos. 74, 75, 76, 77, 202, 205, 210, 212, 213, 215, 221, 223, 224, 225, 245.

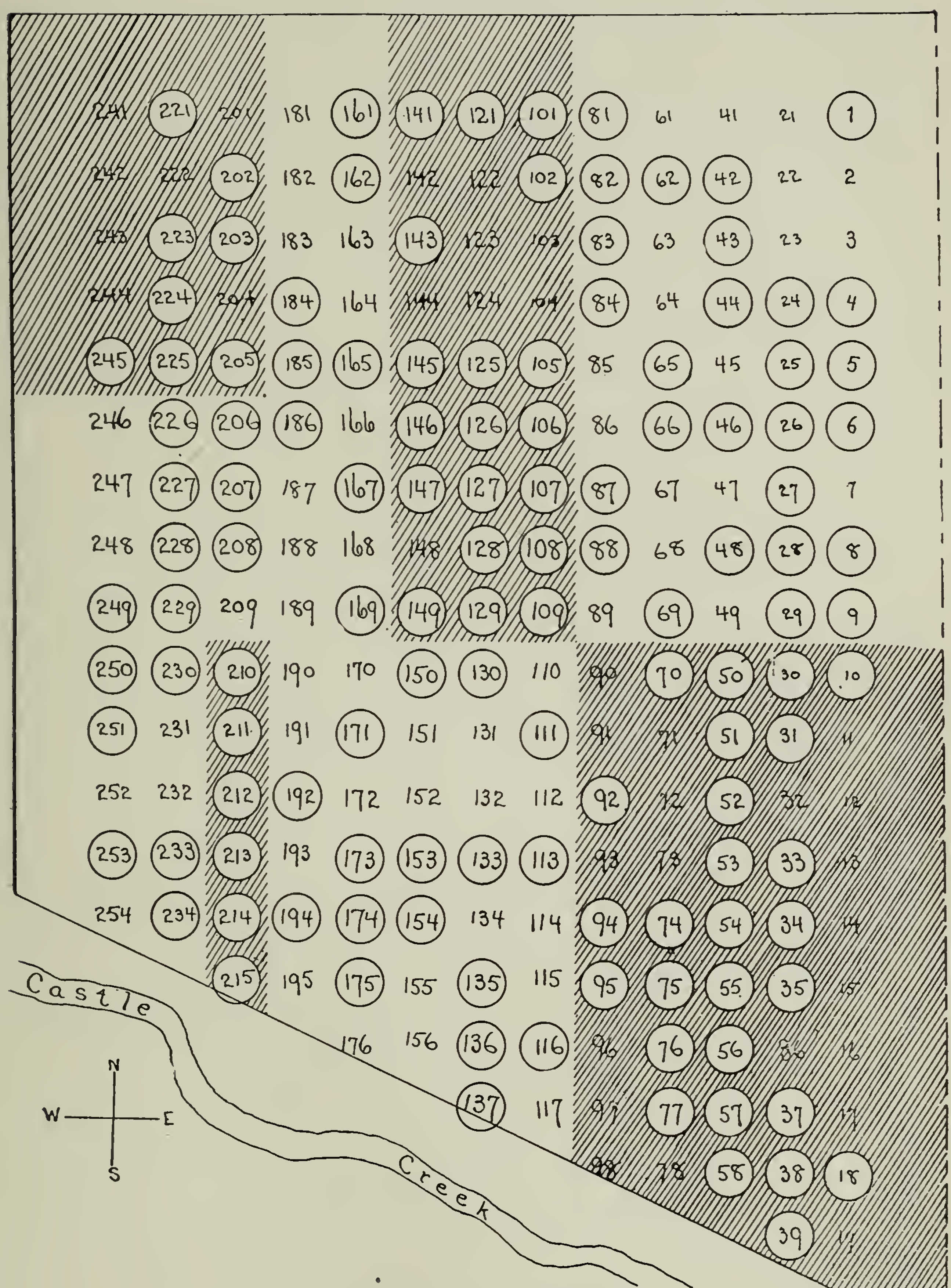
Northern Spy, untreated, Nos. 116, 206, 208, 227, 228, 229, 230, 233, 234, 249, 250, 251, 253.

The shaded portions indicate sections which were treated with ashes.

The old trees are indicated by the circles.

THE VARIETIES.

The orchard was divided into eight sections as already described. For convenience these are numbered consecutively from 1 to 8. Sections 2, 4, 6 and 8 received annual applications of ashes while the others received none. The accompanying plan gives the relative positions of the sections and the varieties of trees included in them. The following list shows the number of treated and untreated trees of each variety which were of bearing age.



PLAN OF THE EXPERIMENT ORCHARD.

	Treated with ashes.	Untreated.		Treated with ashes.	Untreated.
Baldwin	9	6	Golden Russet	....	7
Fall Pippin	7	6	Keswick.	....	1
R. I. Greening	12	18	Peck Pleasant.	....	1
Roxbury Russet	4	4	Maiden Blush	....	1
Northern Spy	15	13	Talman.	....	1
Esopus Spitzenburg	3	4	Vandevere	....	1
Tompkins King	6	1	Summer Pippin	1	.....
Reinette Pippin	2	1	Baldwin (young)	12	17

This list includes 153 bearing trees. Without the young Baldwins there are 124 mature trees in full bearing. Several varieties are not well enough represented in both classes to permit them to be used in comparing treated and untreated sections. Excluding these there still remain forty-seven treated and forty-seven untreated trees, mature and in full bearing, whose records for the five years may be used for determining the results of the experiment. These belong to the following varieties: Baldwin, Fall Pippin, Rhode Island Greening, Roxbury Russet and Northern Spy.

RESULTS OF THE EXPERIMENT.

Records were kept of the September condition of the foliage in 1894-5-6-7 and of the condition June 23, 1894. A careful estimate of the condition of the foliage of each tree was made by two persons and the average of the two estimates was recorded. For obvious reasons it was impossible to examine carefully every leaf and note whether or not it was injured by the scab. Therefore the chief means of determining whether treating the soil with ashes had any influence on the prevalence of the scab was by careful examination of every fruit with reference to this point. During the first three years the fruit was classified with reference to the scab into four classes: (1) free; (2) slight and considerable, averaging about 20 per cent injury if 100 per cent represents a fruit rendered totally worthless by the scab; (3) bad, averaging about 55 per cent injury, and (4) unmarketable, averaging about 85 per cent injury. In 1896 and 1897 the fruit was sorted into

the ordinary commercial grades of first, seconds and culls, but separate account was kept of those which were thrown out of the firsts on account of the scab injury and of those which were thrown out of the seconds for the same reason. These records concerning the foliage and fruit were kept for all trees in the orchard, but only the five varieties mentioned above are reported for the reasons already given.

Observations were also made on the color, keeping qualities and yield of the fruit from treated and untreated sections, although these have no bearing on the subject under investigation.

THE FOLIAGE.

In estimating the condition of the foliage the complete loss of leaves was rated as 100 per cent injury. No record of the condition of the foliage in 1893 was kept. In 1894 observations were made not only in September but also in June, following three weeks of rainy, dark weather, unfavorable to healthy growth of foliage and favorable to the spread of the scab. The average condition of the foliage in treated and untreated sections is shown in Table I.

In 1896 the foliage on both treated and untreated trees was practically perfect, even Fall Pippin showing but a very slight injury. In 1894 and 1897 the treated Baldwin ranked slightly better than the untreated and the two classes graded about alike in 1895. In the treated sections Fall Pippin showed a gain every year. Rhode Island Greening showed a slight improvement each year, Roxbury Russet showed no improvement and Northern Spy ranked about the same in both classes, except that in 1894 the condition of the foliage in the untreated sections averaged somewhat better than in the treated sections. The most marked improvement in the treated sections appears when the June and September condition of the foliage in 1894 are compared. From May 16 to June 5, a period of twenty-one days, it rained every day. During this time there was less than the normal amount of sunshine and the temperature was lower than the average. The trees were sprayed with London purple, 1 pound to 180 gal-

lons. The spray injured the foliage considerably, although lime was added to the mixture to prevent such injury. Under the existing conditions the foliage was unusually susceptible to injury from this cause. It was also very much injured by disease.

From June to September, as shown by Table I, the treated Baldwin gained five points, the untreated lost two; the treated Fall Pippin gained twenty-six, the untreated but eighteen; the treated R. I. Greening gained eleven points, the untreated twelve; the treated Roxbury Russet lost one point, the untreated lost four; the treated Spy lost four points, while the untreated lost nine points. Many of the injured leaves dropped in June and new ones replaced them to a considerable extent, so that in some instances the condition of the foliage in September was much better than it was on the same trees in June, and the sections which received the ashes showed a gain in every instance when compared with the untreated sections.

Taking all years and all varieties into consideration, whenever there was any marked difference in the September condition of the foliage it was in favor of the sections which had received the ashes. Since the estimates include the loss or injury from all causes, including not only the effects of the scab but also of other diseases, insect depredation, etc., they do not necessarily show that the improvement in the foliage on treated sections was due to increased ability to resist the scab as a result of the use of ashes as a fertilizer. The most that can be said is that in many cases there was better foliage where the ashes were used.

The Fruit.

It was very easy to identify the scab on the fruit. During the first three years of the experiment each fruit was graded according to the amount of scab, and a separate record was kept of the number of specimens in each grade for each tree. The first grade contained fruit absolutely free from the disease. If the slightest speck of scab was discovered the fruit was put into the second grade. Fruit which had enough scab to affect its ordinary commercial grade was put into the third grade and the fourth grade contained all fruits which had enough scab to ren-

TABLE I — CONDITION OF FOLIAGE.

NAME.	June 23, 1894.		September, 1894.		1895.		1896.		1897.	
	Treated.	Untreated.	Treated.	Untreated.	Treated.	Untreated.	Treated.	Untreated.	Treated.	Untreated.
	Per cent.	Per cent.	Per cent	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Baldwin	26.0	23.0	21.0	25.0	2.5	2.2	*	*	6.7	7.8
Fall Pippin	53.0	56.0	27.0	38.0	4.6	8.5	1.0	1.0	10.7	14.7
R. I. Greening	24.0	26.0	13.0	14.0	4.4	5.5	*	*	7.9	8.6
Roxbury Russet	19.0	16.0	20.0	20.0	3.0	2.5	*	*	1.2	1.0
Northern Spy	17.0	17.0	21.0	26.0	2.7	2.2	*	*	2.8	2.6

*Almost perfect.

Table II — Average Injury to the Fruit by the Scab.

Name.	1893.		1894.		1895.		1896.		1897.	
	Treated.	Untreated.	Treated.	Untreated.	Treated.	Untreated.	Treated.	Untreated.	Treated.	Untreated.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Baldwin	*	*	28.30	27.05	6.00	6.92	1.24	0.84	1.82	0.83
Fall Pippin	43.08	40.79	69.59	68.21	31.41	40.96	13.04	8.14	13.72	11.15
R. I. Greening	26.30	31.01	58.08	62.06	12.85	11.83	9.66	6.06	7.14	0.57
Roxbury Russet	27.10	29.82	45.15	42.75	3.52	2.98	0.54	0.30	1.56	0.69
Northern Spy	26.47	26.21	38.04	33.21	13.62	12.52	0.53	0.08	3.23	1.86

*In 1893 the treated Baldwins yielded but few fruits and the untreated yielded none.

der them unmarketable. All these grades were made solely on the basis of the amount of scab and the size of the fruit was not considered. Letting 20 per cent represent the average injury from scab in the second class, 55 per cent in the third class and 85 per cent in the fourth class, the percentage of injury which the scab caused to the entire yield of the tree may be computed, thus furnishing a statement by which different trees may be compared as to the amount of injury to the fruit by the scab.

In 1896 and 1897, the fruit was sorted into the ordinary commercial grades of firsts, seconds and culls and the amount of fruit in each grade was recorded for each tree in pounds instead of recording the number of fruits in each grade. The firsts were required to be at least 2½ inches in diameter. An account was kept in each cases of the number of pounds of fruit which were thrown out of the first grade on account of the scab and of those which were thrown out of the second grade for the same cause. This method does not give as accurate a record of the amount of scab on the fruit as the method used in 1893-4-5, for if the fruit was too small to be marketable no account of the scab was kept, nor was any record made of those cases in which the injury from scab was not severe enough to affect the ordinary grading of the fruit. The method does, however, give important testimony on the practical question of the influence which the use of ashes as a fertilizer in the orchard may be expected to have on the relative amounts of firsts, seconds and culls so far as its effect on the scab is concerned. In order to find an expression for each tree for comparing the amount of scab on the different varieties in 1896 and 1897, the average injury to the fruit which was thrown out of the first grade on account of the scab is reckoned at 40 per cent and of that which was thrown into the culls on account of the scab at 90 per cent.

The records which were obtained in the manner just described form a reliable account of the amount of scab on the fruit and a satisfactory basis for comparing the treated and untreated sections. Computing the amount of scab in the way which has already been explained the averages are found which are shown in Table II.

This table shows a slightly greater injury in 1895 with the untreated Baldwins, a greater injury with untreated Fall Pippins in 1895, with untreated R. I. Greenings in 1893 and 1894 and with Roxbury Russett in 1893 than with the treated trees of the same varieties. With these exceptions these varieties show on the average every year greater injury from scab where the ground was fertilized with ashes than on corresponding sections which received no ashes.

In 1896 the season was unusually favorable to the development of perfect fruit, yet with every one of these varieties, the records show a greater average injury from scab on treated than on untreated sections. If apple trees ever needed to be fortified against conditions unfavorable to healthy growth it was in the early summer of 1894, yet in that year, with the exception of R. I. Greenings, every variety named in the table had a higher rate of injury where ashes were used than where they were not used.

This orchard had been sprayed with London purple only, and even in sections treated with the ashes had in some cases lost over half of its foliage from an epidemic of fungous diseases and other injuries following the long period of dark, cool, wet weather. In marked contrast was an adjoining orchard that had been treated with Bordeaux mixture to prevent the scab and whose foliage had been kept in good condition by this means. In the orchard where the ashes were used much of the fruit dropped in June as a result of the loss of the foliage, while the trees which were sprayed with Bordeaux mixture held both the foliage and the fruit and matured a fairly good crop. The great superiority of the Bordeaux mixture for preventing the scab under most unfavorable conditions, as compared with fertilizing the soil with ashes for the same purpose, was thus clearly shown.

CONCLUSIONS.

The investigation has extended over a period of five years, it has included forty-seven trees in full bearing in the treated sections, comparable with the same number of trees representing the same varieties in the untreated sections. The results show

that with the conditions under which this investigation was made liberal applications of hard wood ashes to the soil do not increase the immunity of the apples from the scab.

Whether the result would be the same on soil which is naturally very deficient in potash remains to be demonstrated. The soil in the orchard which was used for this investigation has a fair amount of potash and also of nitrogen and phosphoric acid as shown by the following analyses.

At the close of the experiment samples of soil to a depth of nine inches were taken in each of the eight sections of the orchard. A composite sample was made of the soils which had been treated with ashes and one of the untreated soils. The Chemist reports the following analyses of the air dried samples:

	Treated with ashes. Per cent.	Untreated. Per cent.
Nitrogen	0.186	0.214
Phosphoric acid	0.112	0.128
Potash	0.400	0.480

This shows the percentage of potash which was soluble in hydrochloric acid and not the total percentage in the soil. There was 16.9 per cent of moisture in one case and 17.5 per cent in the other. As far as these analyses go they indicate a fairly uniform condition of fertility in both treated and untreated sections of the orchard.

Some persons have expressed surprise that after the application of potash amounting to 1,000 pounds per acre in five years an analysis of the treated soil does not show a more marked increase in the percentage of potash. Assuming that the soil in this case contains 3,000,000 pounds per acre with 17 per cent of moisture, one analysis shows 9,960 pounds of potash per acre and the other analysis 11,950 pounds per acre in the first nine inches of the soil. An application of 1,000 pounds of potash per acre, supposing that none of it has passed below a depth of nine inches, which is not probable, would not equal the difference which naturally exists in the amount of potash per acre in different parts of the orchard. Moreover, the errors of sampling and analysis might obscure the effect on the soil, of an application of 1,000 lbs. of potash per acre.

There is one difference which should be noticed when comparing the potash which is applied in the ashes with the potash already in the soil, and that is that the potash in the ashes is soluble in water, while that in the soil is largely insoluble in water and is but slowly available to the plant.

SOME RESULTS FOLLOWING THE APPLICATION OF ASHES IN THE APPLE ORCHARD.

Although the use of ashes as a fertilizer did not increase the immunity of the apples from the disease, it showed results in some other ways which interest the orchardist. Observations were made on the color and keeping qualities of the fruit and the productiveness of the trees. The general tendency to more abundant and vigorous foliage on trees in the treated sections has already been noticed.

Color of the Fruit.

Where the soil was treated with ashes, the color of the fruit was much improved with some varieties in some seasons. In 1893 the improvement in the color of the fruit on treated sections was noticeable with all varieties which were represented in treated and untreated sections. The only exception was with one crate of drops from an untreated section which were more highly colored, no doubt because the fruit had been lying on the ground; for it is well known that the color of apples may sometimes be increased by leaving them on the ground exposed to the light. Even the Roxbury and Golden Russets were smoother and higher colored on treated than on untreated sections in 1893.

In 1894 the results were not so uniform. On the treated sections Fall Pippins were smoother and fairer than on the untreated sections. Tompkins Kings were more highly colored on the treated sections than on the one tree on untreated soil. Baldwins showed but little difference, except that in a few cases fruit from the untreated trees was more highly colored than on corresponding treated trees. The reverse was true of the R. I. Greening, for

where any difference was noticeable the treated trees had higher colored fruit, with a riper appearance, more yellow color and a tinge of red. With these exceptions, but little difference could be seen in the treated and untreated sections in 1894 so far as color of fruit is concerned.

In 1895 the results were no more uniform than in the previous year. Remembering that the even numbers represent treated sections, the rank as to color is shown in the following lists where sections are arranged in order according to color of fruit, those having the highest colored fruit being ranked first:

R. I. Greening—Sections 1, 5, 2, 3, 8.

Baldwin—Sections 8, 1, 3, 4, 2, 7.

Roxbury Russet—Sections 2, 3, 7.

Northern Spy—Sections 3, 5, 6, 4, 7.

The Tompkins King had much finer red color where the soil was treated, and on treated soil Spitzenburgs were somewhat superior in color to the same variety on untreated soil.

In 1896 and 1897 there was no noticeable difference in the color of fruit from treated and untreated sections.

The results show that an abundant supply of readily available potash in the soil influences the brilliancy of the color in the fruit. On soil which is naturally well supplied with potash, as this is, and in seasons which are very favorable to the perfect development of foliage and fruit, as was the case in 1896, the colors may develop as perfectly without the application of potash to the soil as with it. In one portion of the original orchard, which has been in sod for years without the application of either stable manures or commercial fertilizers, Northern Spy fruit was produced in 1896 which exceeded in brilliancy of color the Northern Spys which were grown in the cultivated sections where for four years wood ashes had been applied to the soil in liberal quantities. A careful study of the data which have been obtained during the course of this investigation, and which are mostly set forth on previous pages, leads to the conclusion that when the fruit is ready to be gathered the degree of color which it has at-

tained is the result of a combination of various conditions in the environment of the tree at different periods in the development of the fruit. The character and quantity of available plant food, the moisture, texture and mechanical conditions of the soil are some of these conditions. The amount of light and its intensity at different periods in the season, the atmospheric temperature and humidity and the amount of sound foliage are others. Possibly the amount of reserve food material which was stored in the tissues during the previous season may also influence the final result. This idea is suggested by the fact that the foliage during the summer and autumn of 1895 was unusually perfect and the trees were consequently able to store up an exceptionally abundant supply of reserve food material, as is shown by the very abundant crop of the following year. In the early summer of 1896, shortly after the fruit was set, even before it had attained a diameter of an inch, the red color began to show on the red varieties and when mature the fruit was exceptionally well colored.

KEEPING QUALITIES OF THE FRUIT.

For the purpose of comparing the keeping qualities of fruit from treated sections with fruit of the same variety from untreated sections, samples from different sections were put in the fruit house and records were kept of the length of time the fruit kept in good condition. The fruit was sorted over as often as was deemed necessary; those fruits which had begun to decay or had become withered and unfit for market were discarded and a record was kept of the number discarded at each date of sorting. Knowing the date when the fruit was put into the fruit house, it was easy to determine the average length of time during which the apples kept in good condition. These records show that the character of the season has considerable influence in determining the keeping qualities of the fruit. The following table gives the records for 1894, 1895 and 1896. The records for 1897 are not yet complete, while in 1893 the conditions for making comparisons on this point was not satisfactory.

TABLE III. — KEEPING QUALITIES OF FRUIT.

NAME.	Average Number of Days After October 29, During which Samples of Fruit Kept in Good Condition.					
	1894–5.		1895–6.		1896–7.	
	Treated.	Untreated.	Treated.	Untreated.	Treated.	Untreated.
Baldwin	172	144	173	154	203	206
Fall Pippin	*	*	*	*	96	96
Roxbury Russet	68	107	70	106	172	188
R. I. Greening	104	91	122	91	138	166
Northern Spy	86	85	86	92	126	125
Tompkins King	78	79	103	79	116	153
Esopus Spitzenburg	124	90	112	90	163	153
Reinette Pippin	*	*	*	*	102	132

* No record.

The table shows that the effect of the use of ashes on the keeping qualities of the fruit varies with different varieties. In each season the Roxbury Russet from untreated sections kept longer than those from the treated sections. Northern Spy showed but little difference in this respect, while Esopus Spitzenburg from treated sections kept better than from the untreated.

No attempt was made to determine whether there are any differences in structure or composition of the fruit which kept well as compared with that which did not. When mature fruit keeps exceptionally well it may be said to have reached perfect development, whatever that may be. That the season of 1896 especially favored the perfect development of the fruit is shown by the following statement of the average number of days after October 29, during which all varieties mentioned in the table, except Fall Pippin and Reinette Pippin, kept in good condition.

	1894-5.	1895-6.	1896-7.
Treated	105	111	153
Untreated	99	102	164

This also shows that the season of 1896 was exceptionally favorable, while 1894 was not favorable to the perfect development of the fruit. It appears, therefore, that the keeping qualities of the fruit are modified by the character of the season.

Table IV, which is derived from Table III, shows the differences in the number of days during which fruit from treated and un-

treated sections kept in good condition. When the difference is in favor of the treated sections the + sign is used but when it is in favor of the untreated sections the — sign is used.

Table IV.—Difference in Number of Days During Which Fruit Kept in Good Condition.

Name.	1894–5.	1895–6.	1896–7.
Baldwin	+28	+19	— 3
Fall Pippin	*	*	— 0
Roxbury Russet	—39	—36	—16
R. I. Greening	+13	+31	—28
Northern Spy	+ 1	— 6	+ 1
Tompkins King	— 1	+24	—37
Esopus Spitzenburg	+34	+22	+10
Reinette Pippin	*	*	—30

* No record.

The fruit from treated sections generally kept better than that from untreated sections in 1894-5 and 1895-6, the Roxbury Russet being a marked exception. In 1896-7 the fruit from the treated sections kept longer than in the two previous seasons, but it did not generally keep so long as did the corresponding fruit from untreated sections. These considerations lead to the opinion that the perfect development of the fruit was hastened by applying the ashes to the soil. In a season which, like 1896, favors the perfect development of the fruit, the ripening process may be carried too far where ashes are used, and consequently the fruit may not keep so well as it does where no ashes are used. In a season like 1894, unfavorable to the perfect development of the fruit, the use of ashes, on the contrary, may tend to bring a larger proportion of fruit to perfect maturity, or may tend to bring all the fruit more nearly to perfect maturity and thus improve its keeping qualities.

Average Yield per Tree.

This experiment was not undertaken primarily as a fertilizer experiment and it cannot be claimed that its evidence is conclusive as to the effect on the yield of applying wood ashes to the soil in liberal quantities. It cannot be assumed that trees of the

same variety, in the same orchard, have equal capabilities for producing fruit even when they are of the same age and have been propagated, planted and cultivated in the same way. With the data now available no rigid comparisons should be made of the treated and untreated sections for the purpose of drawing definite conclusions as to the influence of the treatment on the yield. It is hoped that the investigation may be continued so as to secure more evidence on this subject.

Table V shows the average yield per tree for each variety from 1893 to 1897, and the annual average per tree for the whole period.

Table V.—Average Yield Per Tree in Bushels.

Year.	Baldwin.		Fall Pippin.		Roxbury Russet.		R. I. Greening.		Northern Spy.	
	Treated.	Untreated.	Treated.	Untreated.	Treated.	Untreated.	Treated.	Untreated.	Treated.	Untreated.
	Bushels.	Bushels.	Bushels.	Bushels.	Bushels.	Bushels.	Bushels.	Bushels.	Bushels.	Bushels.
1893	*	....	0.08	2.01	1.57	0.50	2.58	2.72	5.98	0.14
1894	2.57	2.94	0.74	0.58	6.44	2.80	5.41	4.11	8.64	5.85
1895	6.88	9.81	5.43	3.94	6.89	7.52	8.31	5.55	6.47	6.35
1896	25.56	24.10	20.64	19.77	30.56	21.37	19.14	23.78	19.87	13.40
1897	3.29	2.69	1.41	1.52	12.47	11.24	2.06	1.09	8.68	6.93
Annual average per tree	7.66	7.91	5.66	5.56	11.59	8.69	7.50	7.45	9.93	6.53

* A few fruits.

The annual average shows an increased average yield per tree with Fall Pippin, Roxbury Russet, R. I. Greening and Northern Spy, and a decrease in the case of the Baldwin. The trees are 30 x 30 feet, making 48 to the acre. The average annual increase per acre for the first four varieties named is shown below. The untreated Baldwins averaged 13.44 bushels more fruit per acre annually than did the treated Baldwins.

TABLE VI.—INCREASED YIELD ON TREATED SECTIONS.

NAME.	Annual average increase per tree.	Rate per acre.
	Bushels.	Bushels.
Fall Pippin	0.10	4.8
Roxbury Russet	2.90	139.2
R. I. Greening	0.05	2.4
Northern Spy	3.40	163.2
Baldwin	—0.28	—13.4

An examination of Table V shows that the sections which received no ashes on the whole increased in yield from 1893 to 1896, and in 1897, after the exceedingly heavy crop of the previous year, the yield exceeded that of either of the first two years the orchard was put under experiment. The sum of the average yields of the varieties named in that table are shown below.

	1893.	1894.	1895.	1896.	1897
Treated, bushels	10.21	23.80	33.98	115.77	28.59
Untreated, bushels	5.37	16.28	33.17	102.42	23.47

This shows an increase in the average yield even where no ashes were used, which may be explained by the fact that prior to the spring of 1893 the orchard was in sod, but since that time it has been kept under cultivation.

SCAB RESISTANT VARIETIES.

The data which have been gathered during this experiment throw some light on the question of the variation of different varieties in their natural ability to resist the attacks of the scab fungus. Fall Pippin makes itself conspicuous each year by taking front rank among the varieties which are susceptible to this dis-

ease, while Maiden Blush, even in a most unfavorable season, has comparatively little of the disease. In 1894, as shown in Table VII, the average injury by scab to the fruit of six Fall Pippin trees was 68.2 per cent. An untreated Maiden Blush averaged but 11.74 per cent.

Mr. Paddock has recently examined for me a few varieties of apples to see whether or not there are any structural differences in the epidermis and cuticle of scab resistant varieties like Ben Davis, Grimes Golden and Talman Sweet as compared with susceptible varieties like Fameuse, Esopus Spitzenburg and Rhode Island Greening. So far as he has made examination the resistant varieties have thicker cuticle and thicker walled epidermal cells. This, if it holds true generally, means that the power to resist attacks of the scab fungus is correlated with structural peculiarities and it is quite reasonable to suppose that these scab-resistant characteristics may be intensified by breeding and selection. Work in this direction has already been undertaken with the orange by Mr. H. J. Webber of the Division of Vegetable Pathology, United States Department of Agriculture, in connection with his work for the Division in Florida. He writes under date of January 7, 1898: "In the case of the orange we have found very marked differences in the resistance of certain varieties to disease; for instance, foot rot, the most serious disease with which orange growers have to contend, is controlled mainly by grafting or budding the varieties desired on sour orange stock, which is practically immune from the disease. Again, the sour and bitter-sweet oranges are practically immune to blight, which is also one of the very serious diseases.

"It is not alone fungous diseases, however, that may be treated in this way. The orange rust, which is caused by a surface-feeding Phytops, I feel confident could also be controlled by breeding resistant sorts."

This line of work which Mr. Webber has undertaken in Florida, namely, the breeding of varieties resistant to the attacks of certain insects and diseases, if followed in connection with some of the cultivated fruits of this region might be productive of results

TABLE VII.—INJURY TO UNTREATED TREES.

(Amount of injury to foliage from all causes and injury to fruit by scab; 100 indicating complete loss or injury.)

Number of trees.	NAME.	1893.		1894.		1895.		1896.		1897.		Average for fruit, five years.
		Foliage.	Fruit.	Foliage.	Fruit.	Foliage	Fruit.	Foliage.	Fruit.	Foliage.	Fruit.	
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
6	Baldwin	*	†	25.0	27.05	2.2	6.92	‖	0.84	3.8	0.83	8.91
6	Fall Pippin	*	40.79	38.0	68.21	8.5	40.96	1.0	8.14	14.7	11.15	33.85
18	R. I. Greening	*	31.01	14.0	62.06	5.5	11.83	‖	6.06	8.6	0.57	22.31
4	Roxbury Russet	*	29.82	20.0	42.75	2.5	2.98	‖	0.30	1.0	0.69	15.31
13	Northern Spy	*	26.21	26.0	33.21	2.2	12.52	‖	0.08	2.6	1.86	14.78
4	Esopus Spitzenburg	*	†	31.0	36.30	4.0	51 00	3.0	2.24	5.8	0.80	22.58
1	Tompkins King	*	†	20.0	‡	3.0	8.08	‖	0.12	5.0	1.99	3.40
1	Reinette Pippin	*	48.05	20.0	56.40	3.0	8.48	‖	0.00	8.0	7.19	30.03
7	Golden Russet	*	24.26	21.0	40.57	2.4	2.24	‖	0.20	1.3	1.58	13.77
1	Peck Pleasant	*	41.21	40.0	8.12	2.0	†	‖	3.38	1.0	2.04	13.69
1	Maiden Blush	*	16.66	§	11.74	2.0	8.76	‖	3.55	1.0	0.03	8.15
1	Vandevere	*	34.10	55.0	60.70	3.0	†	‖	11.53	5.0	......	35.44
17	Baldwin (young)	*	23.50	26.0	30.10	2.5	5.92	‖	0.08	4.7	1.56	12.23

* No estimate made. † No fruit. ‡ But little fruit. § Almost perfect. ‖ Trace.

of great value to New York fruit-growers. With varieties of fruit like the apple, which require several years after the seed is planted before coming into bearing, progress by systematic breeding in this direction must be quite slow. In the meantime there appears to be no way of protecting the orchards against the attacks of the apple scab fungus which is so certain to give satisfactory results as spraying thoroughly with the Bordeaux mixture.

REPORT

OF THE

DEPARTMENT OF VEGETABLE PATHOLOGY.

F. C. STEWART, M. S., MYCOLOGIST.*

* At branch station in Second Judicial Department.

TABLE OF CONTENTS.

REPORT OF THE MYCOLOGIST.

F. C. STEWART.

I. THE DOWNY MILDEW* OF THE CUCUMBER; WHAT IT IS AND HOW TO PREVENT IT.†

SUMMARY.

The 1896 crop of late cucumbers in southeastern New York was unusually small—from 17 to 25 per cent of a full crop. The chief cause of the short crop was a disease which caused the leaves to turn yellow and die prematurely. This disease, which is known as downy mildew, was first observed in this country in 1889, since which time it has been rapidly spreading and has become very destructive to cucumbers, muskmelons and watermelons.

In an experiment made at Woodbury, Long Island, the disease was successfully prevented by spraying once every ten days with Bordeaux mixture. Sprayed plants remained green and continued to produce cucumbers for four weeks after unsprayed plants in the same field had lost their foliage and ceased to produce fruit. The net profit from spraying on the experimental plat of one and three-fourths acres was more than one hundred and sixty dollars per acre.

It is probable that the same treatment will protect muskmelons and watermelons against the disease.

There is no good reason for believing that the disease will disappear; on the contrary, it is likely to become more widespread and more destructive. Therefore, it is earnestly recommended that farmers prepare to fight the disease as follows: Beginning when the plants are very small, spray thoroughly with Bordeaux mixture (1-to-8 formula) once every eight or ten

* *Plasmopara cubensis* (B. & C.) Humph.

† Reprint of Bulletin No. 119.

days until frost. The Bordeaux mixture can be satisfactorily applied with a knapsack sprayer, but it may, perhaps, be less expensive to use a barrel spray-pump mounted on a one-horse cart which is hauled through the field along blank spaces felt for the purpose.

INTRODUCTION.

In southeastern New York, particularly in Westchester county and on Long Island, the crop of late cucumbers in 1896 was unusually small. Farmers estimated that cucumbers grown for pickles produced only about one-fourth of a crop; and statistics furnished by the proprietors of various pickle factories on Long Island show that this estimate is very nearly correct. One firm of pickle manufacturers having six salting houses in different parts of Long Island, contracted with farmers to purchase the entire crop of cucumbers on 817 acres at a stipulated price per thousand. From these 817 acres the firm received 15,759,200 cucumbers, which gives an average of 19,288 per acre. In Westchester county the yield was still smaller. A firm having four factories in that county reports that receipts would place the average yield per acre at 13,000.

A fair average crop is considered to be 75,000 cucumbers per acre, and this is the number used by picklemen in computing the acreage capacity of their factories. Until within a few years 125,000 per acre was not an unusual yield; but during the past five or six years the yield has decreased rapidly, reaching so low a point in 1895 and 1896 that the crop ceased to be a profitable one. In spite of the poor crop of 1895, farmers continued to plant heavily in 1896, being loth to give up a crop so admirably adapted to their soil and climate. Moreover they believed that the season of 1895 was exceptional, and that with the return of normal weather conditions the cucumber disease would disappear and the crop continue to be as profitable as it had been in the past. But when the disease reappeared in 1896, more virulent than ever, they became discouraged and many of them decided that they must quit growing cucumbers. Some of the picklemen, too, feared that they would be obliged to close their factories.

CAUSE OF THE FAILURE OF THE CUCUMBER CROP.

It should be borne in mind that what is said under this head does not apply to cucumbers in general but only to late cucumbers, which are grown chiefly for pickling. Such sucumbers are planted from about June 20 to July 4, and commence bearing about August 1. During the picking season all cucumbers more than about one and one-quarter inches long are gathered every other day so that none are allowed to become large and seedy. These cucumbers are universally called "pickles," the name cucumber being applied only to those which are allowed to become nearly or quite full-grown. The latter are sold in the city markets while "pickles," for the most part, are sold under contract to the local pickle factories. The contract binds the farmer to grow a definite number of acres of "pickles" and sell the entire product to the factory at a stipulated price. The customary price for 1896 was one dollar per thousand. Sometimes they are sold by weight. The pickle industry on Long Island is a large and important one.

During the month of August, 1896, the writer visited a large number of cucumber fields in various parts of Long Island for the purpose of ascertaining the cause of the cucumber failure of which farmers were complaining. As there are several fungus and insect enemies of the cucumber, we expected to find that the trouble was not in all cases due to the same cause. It seemed likely that in different fields different causes would be found doing the work of destruction. Such was, in fact, the case, but to a much smaller extent than might be expected.

The striped cucumber-beetle* was found to be doing very little, if any, damage. This insect seldom does serious injury to late cucumbers.

In a few fields the melon-louse† was present in destructive numbers. This is a small, greenish insect, which feeds on the leaves and roots of cucumbers, muskmelons, squashes and various other wild and cultivated plants. Cucumber plants in-

Diabrotica vittata Fabr.
†*Aphis gossypii* Glover.

fested by it can be readily detected by the curling of the leaves. On the under surfaces of the curled leaves the insect may be found in immense numbers sucking the juice from the plant. It is to be observed that the melon-louse generally works from the edges of the field toward the center. The explanation is this: The insect feeds upon quite a variety of weeds, such as the dandelion, dock, shepherd's purse, plantain, etc., which are abundant along the margins of cultivated fields. When the cucumber plants appear the lice leave the weeds and go to feed upon the cucumber leaves which are more to their liking, and thus it is that they work from the edges of the fields to the center.

In the vicinity of Huntington some damage was done by the boreal lady-bird beetle* which is a hard-shelled beetle, about three-eighths of an inch long and nearly as wide, and very convex. Its color is dirty yellow with black spots. Both the beetle and its larva feed upon the cucumber leaves—the beetle from the upper surface and the larva from the under surface. Their work is conspicuous and readily recognized as insect work.

A disease which did more damage that all the above named insects is a mysterious wilt disease which is characterized as follows: At almost any time after the plants have commenced to run they suddenly wilt without any apparent cause. In some cases the whole plant wilts; in others a portion of the plant or, perhaps, a single leaf, while the remainder remains healthy. Healthy plants and diseased plants may be frequently found in the same hill. A casual examination of plants recently wilted reveals nothing which could cause the death of the plant and so this disease is indeed a puzzle to the farmer. But in the later stages of the disease a rotten spot may generally be found at the base of a wilted leaf or somewhere on the main stem. Microscopic examination shows that in the neighborhood of the rotten spots the tissues are swarming with exceedingly minute germs called bacteria, and these are the cause of the trouble. Dr. Halsted, who has given considerable study to the wilt disease of

* *Epilachna borealis* Fabr.

cucumbers, melons, etc., is of the opinion that the bacterium which causes this disease of cucurbitaceous plants is identical with the one which causes a wilt disease of potatoes and tomatoes, common in the Southern States and not infrequently found as far north as the latitude of New York City. But recent investigations made by Dr. Erwin F. Smith* show that the wilt disease of potatoes and tomatoes has no connection whatever with the cucumber wilt. He attempted to transmit the disease from the cucumber to the tomato and potato by artificial inoculation but failed in every case. Moreover, he comes to the conclusion† that there are two distinct wilt diseases of the cucumber. Which one of these caused the wilting of Long Island cucumbers the past season we do not know. Along what is known as the Port Jefferson Branch of the Long Island Railroad the loss from the cucumber wilt was considerable, although not so great as the loss from downy mildew to be mentioned later.

In the present state of our knowledge of the wilt disease no remedy for it can be recommended. Rotation of crops has been suggested as a remedy and probably it does tend to lessen the virulence of the disease, but it cannot be relied upon. The past season we found a bad case of cucumber wilt in a field that had been in grass for twelve years. It seems probable that the disease can be communicated by means of cucumber seed.

It is well known that the white grubs (larvæ) of the striped cucumber-beetle feed upon the roots of cucumber plants, and when present in large numbers they may cause the plants to wilt. When present they are readily detected. It is safe to say that almost none of the wilt of late cucumbers on Long Island in 1896 was due to this cause.

We now come to the consideration of the chief cause of the "poor pickle crop" of 1896; namely, the downy mildew. The symptoms of this disease are as follows: The leaves show yellow spots which have no definite outline. If the weather is warm and favorable for the disease these spots enlarge rapidly and run

* Smith, Erwin F.—A Bacterial Disease of the Tomato, Eggplant and Irish Potato. Bull. No. 12 U. S. Dept. of Agriculture, Division of Vegetable Physiology and Pathology. Issued Dec. 19, 1896.

† Loc. cit. p. 6.

together so that the whole leaf becomes yellow and soon dies and shrivels like a leaf killed by frost. If the weather is cool the yellow spots spread less rapidly. In the latter case the central portion of the yellow spots becomes dead and brittle and of a light-brown color. For an illustration of this see Plate X. The disease invariably begins with the oldest leaves and proceeds toward the tips of the vines. Hence the disease appears to proceed from the center of a hill outward. In a field recently attacked, the center of every hill will be clearly marked by a cluster of yellow leaves, so that the rows may be plainly seen clear across the field, even though the plants are large and cover the ground. Affected plants continue to grow at the tips and put out new leaves, and it is interesting to note how the disease follows at a distance of about four or five leaves behind the growing tip. After the disease is once thoroughly established, very few cucumbers are produced although the plants may continue to flower profusely. The few cucumbers which are formed grow slowly and become misshapen so that they are unsalable.

Besides the downy mildew there are several other fungous diseases which sometimes do damage to cucumbers, but the downy mildew was the only one which did serious harm to late cucumbers on Long Island in 1896. The anthracnose, *Colletotrichum lagenarium* (Pass.) Hals., has recently done much damage to cucumbers in New Jersey, but it has not been destructive on Long Island during the past season. Of the total shortage of 75 per cent in the Long Island cucumber crop of 1896 it is safe to say that 55 per cent was due to the downy mildew, while the remaining 20 per cent was due to all other diseases and insects. In the vicinity of Hicksville and Central Park practically all of the damage was done by the downy mildew.

STRUCTURE OF THE CUCUMBER LEAF.

In order that the nature of the downy mildew and its method of killing the leaves may be better understood, it is perhaps best to first describe the structure of the cucumber leaf.

Plate X.—A Cucumber Leaf Affected with Downy Mildew.

To the naked eye a piece of cucumber leaf is structureless; but if a very thin cross-section is cut and placed under a compound microscope which magnifies about 390 diameters, it is found to be made up of numerous compartments or cells, some of which contain many green bodies, the chlorophyll grains. Fig. 1, Plate XI, is a drawing of a small portion of such a cross-section. Above and below there is a layer of colorless cells (*a*, *á*) called the epidermis (*a* is on the upper face of the leaf, *á* on the lower). The epidermis is an impervious protective covering for the leaf. Between *a* and *á* we find cells of various shapes. Near the upper surface of the leaf they are much elongated and are called palisade cells (*b*, *b*). Toward the lower surface they are more nearly spherical. In each of these cells there are several small green bodies (*c*) the chlorophyll grains which give the green color to the leaves. Fig. 2 of the same plate is a drawing of a portion of the epidermis or skin, peeled from the lower surface of the leaf. The elliptical objects (*s*), are stomata (sing. stoma). Between the two cells composing a stoma there is a narrow slit (*r*) which opens into an intercellular passage on the interior of the leaf. At *m* in Fig. 1, there is shown a cross-section of the two cells of a stoma, just beneath the intercellular passage (*i*). On the under surface of the leaf the number of stomata to the square inch is more than 400,000, while on the upper surface there are about 165,000 per square inch. The epidermis of the upper surface of the leaf resembles closely that of the lower surface, except that there are fewer stomata. On both surfaces of the leaf there are hairs which can be seen with the naked eye. These hairs are of two kinds: (1) long, tapering hairs like the one shown in Fig. 2, and (2) short hairs with large, swollen tips, called glandular hairs.

NATURE OF THE DOWNY MILDEW.

The symptoms of this disease have been given on a previous page. The naked eye can detect nothing about the diseased leaves which could cause the yellow spots and consequently they are a puzzle to farmers. As in the case of many other plant

diseases, the cause of which is not known, the blame had been laid upon the weather. Fortunately the compound microscope comes to our aid here and makes the whole matter perfectly plain. If a fragment of leaf taken from one of the yellow spots is magnified about 390 diameters, there will be seen a large number of such things as are figured in Plate XII. These constitute the downy mildew fungus, *Plasmopara cubensis*, which is the real cause of the yellow spots. It is not an insect. It is a vegetable growth and is just as truly a plant as is the cucumber plant itself. At Fig. 1 there is shown a branched sporophore (*s*) bearing several young spores (*sp*). The sporophores are nearly colorless and come out through the stomata on the under surface of the leaf, the branched tops hanging downward. Fig. 3 shows one young and one mature sporophore* coming through a stoma (*st*). When the spores are mature they are violet colored and usually have the form shown in Figs. 2, 2′ and 2″. These spores are readily carried by the wind for a long distance. Should one chance to fall upon a cucumber leaf and find there a drop of dew or other moisture, it will germinate in a few hours by discharging several small protoplasmic bodies called zoöspores. Each of the zoöspores may put out a germ-tube which finds it way through a stoma to the interior of the leaf, where it forms a net-work of colorless fungus threads (hyphae) which run here and there among the cells. At frequent intervals the hypae put out knob-like outgrowths which penetrate into the cells and feed upon the cell contents. See Fig. 7, Plate XII. The fungus is, therefore, a parasite, appropriating to its own use the nourishment which the cucumber plant has prepared. Besides abstracting nourishment, the fungus probably does further injury by poisoning the cells and causing them to die quickly. After the fungus has vegetated within the leaf for a while it forms sporophores which push out through the stomata and produce another crop of spores. The length of time required for the completion of this life cycle is not known, but it is certainly short, probably less than twenty-four hours. Thus

*The number of sporophores which proceed from a single stoma is small, usually one or two; but it is not uncommon to find as many as five, and even larger numbers are occasionally seen.

the disease spreads from plant to plant with great rapidity. In what form the fungus passes the winter is not known. The ordinary conidal spores, described above, retain their germinating capacity for a short time only. Some species of closely related fungi produce, in addition to these ordinary spores, thick-walled resting spores, which retain their power of germination for a long time and serve to carry the fungus over the winter or other unfavorable period. No such spores have been found in connection with *Plasmopara cubensis*.

The large, short-stalked spores* shown in Figures 4, 5 and 6 are a modified form of the ordinary conidia. Spores of this character are known to occur occasionally in a few other species of Peronosporae, the family to which *Plasmopara cubensis* belongs; but it is unusual for them to occur in such large numbers as we have found them in this species.

The downy mildew fungus likes hot weather and a moderate rainfall. The time of worst attack is generally in August. During the first half of last August there was a period of ten days of excessively hot weather. The disease spread with such alarming rapidity that by August 20 the majority of cucumber fields were ruined. The influence of moisture is seen when diseased cucumber leaves are placed for about twenty-four hours in a tight tin box containing blotting paper saturated with water. In this moist atmosphere the sporophores attain a greater length and produce myriads of spores which give to the diseased spots a decided violet tinge. The spores are so numerous that when a leaf is suddenly jarred they fall like a cloud of violet-colored dust. Under the microscope the fungus is seen to be in a state of active

*These peculiar spores do not seem to have been previously observed as they are not mentioned in the literature of this species. The writer found them in abundance during August on field-grown cucumbers and muskmelons. On both of these plants one or more such spores might be found on nearly every surface section taken from the under surface of the leaves. They closely resemble the ordinary conidia except that they are considerably larger. The sessile form (Fig. 5) is much more common than the stalked form (Fig. 4). On page 311 of the *Botanical Gazette* for 1883, Dr. Farlow mentions having seen similar spores in *Peronospora geranii*, Pk. and *Peronospora violae*, DBy; and Dr. Max Cornu has described and figured such spores found in connection with *Plasmopara viticola*. See his article, *Le Peronospora des Vignes*.

In the opinion of the writer these spores should be considered abnormal and due to some unfavorable condition, probably insufficient moisture. As previously stated, they were found in abundance on leaves collected in dry weather; but they were rarely found on leaves collected on damp days or on leaves kept in a moist chamber.

growth—spores may be found attached to the sporophores and in all stages of growth; and the bases of the sporophores are surrounded by huge masses of protoplasm like the one shown at Fig. 1, Plate XII. Whereas, on leaves taken from the open in dry weather, the fungus does not produce spores in such profusion as to color the leaf spots; no masses of protoplasm are to be found at the bases of the sporophores; and it is rare that immature spores can be found attached to the branches of the sporophores.

BOTANICAL RELATIONSHIP OF THE DOWNY MILDEW FUNGUS.

Botanists have grouped the higher plants into families and given these families Latin names. For example, we have the Gourd Family or Cucurbitaceae, which contains the gourd, muskmelon, watermelon, cucumber, squash, pumpkin and other similar plants. The numerous species of fungi have been grouped into families in the same manner, and so we have the family of smuts or Ustilagineae, which contains all the species of smut fungi, such as corn smut, oat smut, onion smut, etc.; the family of Rusts or Uredineae, which contains the various species of rust fungi, and many other families.

The cucumber downy mildew fungus has the Latin name, *Plasmopara cubensis*, and it belongs to the family of Downy Mildews or Peronosporeae. This is a family which contains many species of fungi injurious to cultivated plants. Some well known examples are: The dreaded potato-blight, *Phytophthora infestans*, the downy mildew of the grape, *Plasmopara viticola*, the spinach mildew, *Peronospora effusa*, and the onion mildew, *Peronospora schleideni*. But the downy mildews should not be confused with the powdery mildews, such as gooseberry mildew and the common rose mildew. These are quite different in structure and belong to the family Erysipheae.

HOST PLANTS.

The plant upon which a fungus lives is called its host plant. *Plasmopara cubensis* has several host plants, all of which belong to the Cucurbitaceae. It was originally discovered on a wild

plant in Cuba; and has since been found on the cucumber (*Cucumis sativus*), the muskmelon (*Cucumis melo*), the watermelon (*Citrullus vulgaris*), the squash (*Cucurbita maxima*), the pumpkin (*Cucurbita pepo*) and the gherkin gourd (*Cucumis anguria*). It is likely that when the fungus becomes better known it will be found on still other cucurbitaceous plants. During an outbreak of the disease in New Jersey in 1891, Dr. Halsted* sought for it on the star cucumber (*Sicyos angulatus*) and the wild cucumber (*Echinocystis lobata*) but failed to find it.

On both field-grown and hot-house cucumbers it is exceedingly destructive. The muskmelon, too, suffers severely from its attacks. Muskmelon plants attacked by the disease lose their leaves in much the same manner as do cucumber plants, except that the yellow discoloration is less marked in the muskmelon and the dead spots are dark colored. The diseased plants may continue to produce melons but they are of a very inferior quality. The watermelon is affected in the same way. Dr. Halsted attributes† the partial failure of the New Jersey watermelon crop in 1891 to this fungus. On the squash and pumpkin the disease presents the same general appearance as on the cucumber, but as yet it has not done much harm to these plants. However, it seems to be on the increase and it is not improbable that in the near future Long Island squash growers will have to fight this disease or abandon the crop just as cucumber growers are doing now.

HISTORY OF THE DISEASE.

The disease with which we are dealing has a comparatively short history. It was originally discovered on a wild plant in Cuba and the fungus causing it was first described‡ in 1869 by Berkeley and Curtis, who gave it the name *Peronospora cubensis*. For the next twenty years nothing was heard of it and then in 1889 it suddenly appeared in Japan and in New Jersey. The first announcement of its occurrence in this country is to be found on page 152 of the *Botanical Gazette* for June, 1889. Dr. Halsted,

*Halsted, B. D. Notes upon Peronosporeae for 1891. Ann. Rept. New Jersey Agricultural Experiment Station for 1891, p. 248.

†Loc. cit.

‡Journal Linnaean Society, Botany, Vol. 10, p. 363.

the author of that article, states that he found the fungus on cucumber leaves growing under glass at New Brunswick, N. J. Subsequently, he reported* that it had been found abundantly in various parts of New Jersey in 1889, not only on forced cucumbers but also on squashes, pumpkins and field-grown cucumbers. In the *Botanical Gazette* for August, 1889, Dr. Farlow gave a detailed account of the fungus and stated that it had been found in Japan a few months before by Prof. Miyabe. In the same year, 1889, Prof. Galloway† reported having received specimens from Anona, Fla., and College Station, Texas, in both of which localities it was abundant.

In 1890 Dr. Humphrey‡ studied the fungus at the Massachusetts Experiment Station. He made the first drawings of the spores§ and sporophores, and the hyphae penetrating the cells of the leaf; and because of the manner in which the spores germinate he changed the name to *Plasmopara cubensis*.

Following this, the fungus was reported from various parts of the country. It began to do serious injury to muskmelons and watermelons, and has now become so injurious to cucumbers and melons that it must be placed in the front rank of destructive fungous diseases. According to Ludwig‖ it has not yet been found in Europe.

It is a curious freak of nature that a fungus which had not been observed for twenty years should appear almost simultaneously in two widely separated portions of the earth and so suddenly spring into prominence as a destructive disease.

AN EXPERIMENT ON THE PREVENTION OF THE DISEASE BY SPRAYING WITH BORDEAUX MIXTURE.

In the season of 1896, the Station made arrangements with Mr. R. C. Colyer, of Woodbury, N. Y., to make a spraying experiment

* Halsted, B. D. Some Notes upon Economic Peronosporeae for 1889 in New Jersey. Journal of Mycology, Vol. V., p. 201.

† Galloway, B. T. New Localities for *Peronospora Cubensis*. Journal of Mycology, Vol. V, p. 216.

‡ Humphrey, J. E. Eighth Ann. Rept. Mass. Agl. Exp. Sta., 1890, pp. 210-212.

§ He did not, however, illustrate the germination of the spores although he distinctly states that the method of germination is by zoöspores and because of this character places the fungus in the genus *Plasmopara*. Dr. Halsted, also, has observed that the germination is by means of zoöspores, but no one has ever figured them.

‖ Ludwig, F. Lehrbuch der Niederen Kryptogamen, p. 150.

on one of his fields of late cucumbers. This field had an area of about one and three-fourths acres, and was planted about July 1, in forty-two rows, each containing one hundred and three hills, the rows being five feet apart and the hills four feet apart in the row. It was planned to spray a part of the field with Bordeaux mixture and leave another part unsprayed for comparison. Bordeaux mixture was selected for use in the experiment because it is known to be a preventive of the downy mildew of the grape, the late blight of potatoes and other diseases caused by fungi belonging to the family of downy mildews. The downy mildew of the grape is caused by the fungus *Plasmopara viticola* which is a near relative of the cucumber downy mildew fungus. Grape growers no longer fear this once troublesome disease because they know that Bordeaux mixture applied at the proper time will certainly prevent it.

The writer, knowing the nature of the cucumber disease and the value of Bordeaux mixture for such diseases in general, was confident that the cucumber crop could be saved by spraying the plants with Bordeaux mixture before the disease made its appearance. Acting upon this idea we prepared a brief newspaper article in which the nature of the cucumber disease was explained and an outline given of what seemed likely to be a successful method of treating it. This article was published in June in some of the local newspapers, viz., the *Island*, published at Floral Park; the *Enterprise*, published at East Norwich; and the *Long Islander*, published at Huntington. It appears that no attention was paid to this article. We know of no instance in which any attempt has been made on Long Island to prevent the cucumber disease by the use of Bordeaux mixture, excepting, of course, our own experiment and the cases of three or four farmers who, having seen the results of this experiment, made an attempt to save their cucumbers after the disease had attacked them. The Bordeaux mixture has been used on Long Island very little for any purpose. The past season several farmers sprayed potatoes and a few have sprayed their orchards, but this excellent fungicide should be better known here.

Humphrey,* Lodeman† and some other writers have suggested spraying for cucumber downy mildew, but we believe that the only record experiment is one made by Halsted‡ who reports that cucumber plants sprayed with Bordeaux mixture held their leaves longer than unsprayed plants. The results of that experiment were somewhat complicated by the fact that the unsprayed plants suffered severely from attacks of anthracnose§ as well as downy mildew. Hence it seemed desirable to have more experimental evidence of the efficiency of Bordeaux mixture as a preventive of cucumber downy mildew.

Let us now return to our own experiment: The forty-two rows of cucumber plants were divided into five plats as shown in the accompanying diagram.

PLAN OF EXPERIMENTAL FIELD.

Plat I. 10 rows; sprayed 7 times.
Plat II. 6 rows; not sprayed.
Plat III. 10 rows; sprayed 7 times.
Plat IV. 6 rows; center 2 rows sprayed four times, the other four not sprayed.
Plat V. 10 rows; sprayed 7 times.

*Humphrey, J. E. Tenth Ann. Rept. Mass. Agr. Exp. Sta., 1892, p. 227.

†Lodeman, E. G. The Spraying of Plants, p. 315.

‡Halsted, B. D. Experiments with Cucumbers, Rept. of the New Jersey Agricultural College Experiment Station for 1895, p. 303.

§*Colletotrichum lagenarium* (Pass.) Hals.

CHRONOLOGICAL RECORD OF THE FIELD.

July 13. *First Spraying.* The plants were well up, the majority of them having two leaves besides the seed-leaves. Plats I, III and V were sprayed with Bordeaux mixture (1-to-7 formula). Thirty-six gallons of Bordeaux mixture were used and the time consumed in making and applying it was about three hours. Plats II and IV not sprayed.

July 24. *Second Spraying.* The plants had been growing very rapidly and appeared to be in perfect health. Plats I, III and V sprayed again (1-to-7 formula). Bordeaux mixture used, 58 gallons. Time, 5 hours. Plats II and IV not sprayed.

July 30. On the plants in Plats I, III and V many leaves were yellow around the margins, while the plants in Plats II and IV were in perfect health and showed none of the yellow leaves. Thus it appeared that the injury was due to the Bordeaux mixture applied on July 24. Two questions now arose, viz.: Had the Bordeaux mixture been improperly prepared? or, Had it been used in a too concentrated form?

August 3. *Third Spraying.* The plants on Plats I, III and V still showed decided injury. Plats II and IV were perfectly healthy. Plats I, III and V sprayed again. Fearing that the Bordeaux mixture had been too strong in the first two sprayings, the 1-to-11 formula was used this time. Bordeaux mixture used, 75 gallons. Time, 6 hours. In order to determine whether the injury from Bordeaux mixture in the second spraying was due to a too concentrated mixture, the center two rows in Plat IV (which up to this time had not been sprayed at all) were treated as follows: One row was sprayed with carefully prepared Bordeaux mixture of the 1-to-7 formula and the other row with Bordeaux mixture of the 1-to-11 formula. Hereafter, these two rows will be referred to as "test rows."

August 7. The first appearance of the yellow spots of the downy mildew.

August 8. The first picking was done on this date.

August 12 and 13. *Fourth Spraying.* The third spraying did no injury to the plants. Neither had there been any injury to either of the two test rows in Plat IV. The unsprayed plants in Plats II and IV were now severely attacked by the downy mildew—every hill showed the characteristic yellow spots. While on Plats I, III and V only an occasional yellow spot could be found. The test rows in Plat IV showed more disease than Plats I, III and V but considerably less than the unsprayed plants in Plats II and IV. The test rows were again sprayed as on August 3. Plats I, III and V sprayed again (1-to-11 formula). Bordeaux mixture used, 105 gallons. Time, 9 hours.

August 21. *Fifth spraying begun.* On this date the contrast between the sprayed and the unsprayed plats was very striking. Plats I, III and V were perfectly green, in excellent health and producing an abundance of cucumbers; while Plat II and the unsprayed rows on Plat IV were yellow throughout, many leaves were completely dead and picking was practically finished. The test rows in Plat IV showed no injury from spraying, and they were not nearly so badly diseased as the unsprayed rows beside them. Plat V and two rows of Plat III were again sprayed. This time it was thought best to use the 1-to-8 formula. A close examination of the sprayed plants showed that the disease was getting started among them and it was feared that the Bordeaux mixture used in the last two sprayings might not have been strong enough to check the disease. The experiment on the test rows in Plat IV showed that the stronger mixture could be safely used if it were properly prepared. The quantity of Bordeaux mixture used this time was 50 gallons and the time required to apply it, 4 hours. On the night of August 21st, there was a heavy rain and on the 22d and 23d drizzling rains fell so that no more spraying was done until the 24th.

August 24 and 25. *Fifth spraying finished.* The heavy rains had washed off so much of the Bordeaux mixture that it was deemed advisable to re-spray the plants sprayed on August

21. Plats I, III and V were, therefore, given a thorough spraying on August 24 and 25. Quantity of Bordeaux mixture used, 150 gallons. Time, 10 hours. The test rows were again sprayed.

September 2 and 3. *Sixth spraying.* At this time the unsprayed plants had no green leaves except a few at the ends of the vines. The sprayed plants, on Plats I, III and V were considerably diseased but continued to yield about 30 baskets of cucumbers every other day. They were again sprayed with the 1-to-8 formula. Bordeaux mixture used, 100 gallons. Time, 6 hours. Less Bordeaux was required this time because there had been very little rain since the last spraying. Time was saved by using two nozzles, instead of one, as in all previous sprayings. The test rows were again sprayed.

September 8 and 9. *Seventh spraying.* Among the sprayed plants the disease was slightly worse than on September 2; but, in spite of this, two pickings had been made during the week, the one made September 7 yielding 40 baskets of cucumbers. The test rows on Plat IV, were now little better than the unsprayed rows. Plats I, III and V, sprayed again (1-to-8 formula). Bordeaux mixture used, 100 gallons. Time, 6 hours. Two nozzles were used as in the sixth spraying.

September 21. The vines were badly diseased but still retained considerable of their foliage. As late as September 19, eleven baskets of cucumbers were taken at one picking.

September 23. Five baskets of cucumbers were picked on this date. The vines were killed by frost during the night of September 23-24.

HOW THE SPRAYING WAS DONE.

Thirty rows were sprayed seven times and two rows four times with Bordeaux mixture made by the potassium ferro cyanide test and applied with an Eclipse knapsack sprayer. Spraying was begun July 13, when the plants had but two leaves, and continued, at intervals of from six to eleven days, until September 9. The remaining ten rows were not sprayed at all.

THE EXTENT TO WHICH SPRAYING PREVENTED THE DISEASE.

The downy mildew first appeared on the unsprayed plants August 7, and by August 21 it had injured the foliage to such an extent that scarcely any cucumbers were produced after this date. The damage was done almost wholly by the downy mildew. The thirty-two rows of plants which had been sprayed were in perfect health and vigor on August 21, and *after this date produced two hundred sixty dollars* worth of cucumbers* which represents approximately the benefit resulting from spraying.

This benefit would, without doubt, have been considerably larger if no unsprayed plants had been left. On the unsprayed plants in Plats II and IV, the fungus was allowed to grow unchecked and produce immense number of spores which the wind scattered broadcast over the sprayed plants. These spores could not attack the leaves from the upper side because of the Bordeaux mixture. Probably they dropped to the ground and were carried to the undersurfaces of the leaves by the spattering of rain drops. Here there was no Bordeaux mixture to hinder them and so they readily gained access to the tissues of the leaf. As a result, about August 21, the yellow disease-spots could be occasionally found on the leaves of sprayed plants and from this time on the disease gradually spread and shortened the crop considerably. Had all the plants in the field been sprayed, the disease could not have obtained a start. The soil on which the plants grew could not have been originally infested by the fungus because no cucumbers had been grown on it for several years. Hence, the only source from which the plants could receive infection would be the spores coming from the neighboring fields, the nearest of which was one-fourth mile away. Under these conditions comparatively few spores would have fallen upon our experimental field and it is very probable that we could have kept the plants in perfect health until frost.

*The actual amount was more than this, but exactly how much we do not know, and desiring to be strictly within the limits of truth we will place it a little low and call it two hundred sixty dollars. It is to be regretted that an exact record of the yield on the different plats was not kept. The cucumbers were sold in the Wallabout Market, Brooklyn, and because of the scarcity of cucumbers, they brought, on an average, nearly four times the price which picklemen were paying for cucumbers raised on contract.

The experimental field, being near a public highway, attracted a great deal of attention. Some who knew nothing of its history, were much puzzled by its appearance and stopped to inquire why it was so "streaked." Such was the interest in it that farmers who had heard of the experiment came from several miles around to see what had been accomplished by spraying. The contrast between the sprayed and unsprayed portions of the field was very striking. See Plate XIII.

EXPENSE OF THE TREATMENT.

The items of expense are as follows:

Seven hundred and six* gallons of Bordeaux mixture at an average cost of two-thirds of a cent per gallon....	$4 71
Forty-nine hours labor applying the Bordeaux mixture at 15 cents per hour..............................	7 35
Expense of carting 706 gallons of water, about.......	2 25
Total..	$14 31

The thirty-two rows sprayed contained 3,296 hills and covered an area of a trifle more than one and one-half acres. The expense per acre was, therefore, $9.50. Spraying increased the crop on this one and one-half acres by the amount of $260, which is at the rate of $173 per acre. Deducting from the latter amount the expense of spraying one acre, $9.50, we have left *$163.50 net profit per acre.*

STRENGTH AND QUANTITY OF BORDEAUX MIXTURE USED IN THE EXPERIMENT.

It will be observed that in the course of the experiment three different strengths of Bordeaux mixture were used. The experiment would have been more satisfactory if a single strength could have been used throughout the season. But the second spraying injured the plants and it was suspected that the Bordeaux mixture used (1-to-7 formula) had been too strong. Accordingly, the next two sprayings were made with weaker mixture (1-to-11 formula). At the time of the fifth spraying it was

*This includes the 674 gallons used on Plats I, III and V, and 32 gallons used on the two test rows in Plat IV.

discovered that the disease was beginning to attack the sprayed plants and it was feared that the mixture used in the third and fourth sprayings had not been strong enough to prevent the germination of the fungus spores; and in the meantime it had been ascertained that the injury done by the second spraying was due to the Bordeaux mixture having been improperly prepared. So in the fifth, sixth and seventh sprayings we used Bordeaux mixture of the 1-to-8 formula.

Further experiments are necessary to determine what strength of Bordeaux mixture will be the most satisfactory. The weaker the mixture the less will be the expense of spraying, but, of course, it must be strong enough to kill the fungus spores. Judging from the behavior of the two test rows in Plat IV, one of which was sprayed with 1-to-11 Bordeaux and the other with 1-to-7 Bordeaux, it seems probable that Bordeaux of the 1-to-11 formula will prevent the disease just as effectually as stronger mixtures. This opinion is strengthened by the fact that the grape downy mildew is readily controlled by 1-to-11 Bordeaux.

The quantity of Bordeaux mixture which it is necessary to use at each application depends upon the size of the plants, the amount of rainfall and the frequency with which the plants are sprayed. The quantity required for the first spraying is small as compared with the quantity required when the plants are full grown. If the plants are sprayed once a week and there is little rain between the sprayings, the quantity required each time will not be nearly as great as when the plants are sprayed at longer intervals and heavy rains occur.

In the experiment, the quantity of Bordeaux mixture used in the several sprayings was as follows:

First spraying	25 gallons per acre.
Second spraying	41 gallons per acre.
Third spraying	53 gallons per acre.
Fourth spraying	74 gallons per acre.
Fifth spraying	141 gallons per acre.
Sixth spraying	71 gallons per acre.
Seventh spraying	71 gallons per acre.
Total of seven sprayings	476 gallons per acre.

TIME REQUIRED TO APPLY BORDEAUX MIXTURE.

Applying Bordeaux mixture with a knapsack sprayer is hard work; hence the amount of work done depends largely upon the strength of the laborer. Experience gained from this experiment and potato spraying experiments, shows that an active man of average strength can make and apply from 125 to 150 gallons of Bordeaux mixture in a day of ten hours, using an Eclipse knapsack sprayer with a single Vermorel nozzle. This quantity can be increased to from 150 to 175 gallons per day by using two nozzles, but when two nozzles are used it is necessary to keep the pump handle working almost constantly, which makes the work harder. In spraying cucumbers two nozzles can be advantageously used in the later sprayings, provided the laborer is strong and willing to work.

MR. COLYER'S OPINION OF THE EXPERIMENT.

The following statement from Mr. R. C. Colyer, of Woodbury, L. I., N. Y., on whose premises the experiment was made, explains itself. Mr. Colyer writes as follows:

"The unsprayed vines were a failure—the blight affected them before they commenced to pick. The pickles grew crooked and pointed so that when they were counted about one-fourth of them had to be thrown out and the balance were unsatisfactory at the salting-house. The blight affected them so fatally that in about two weeks they ceased picking. The sprayed vines grew vigorously—the blight did not affect them apparently. The pickles grew perfect and all were salable. The spraying preserved the vines until they were killed by the frost, September 24th. The vines were yielding fairly well when the frost came. This experiment with Bordeaux mixture on the pickle vines was a success. The crop from the vines sprayed was very profitable to me. The blight was general last year, the main part of the crop being destroyed about the middle of August. Very few farmers were picking as late as September 1. The pickles that grew on these vines preserved by the application of the Bordeaux mixture, sold in Wallabout market, Brooklyn, at an average price of about

four dollars per thousand for the large ones and three dollars per thousand for the small ones. giving me more than $260 profit from the sprayed vines after the unsprayed vines were dead.

"I have been growing pickles for the New York market and for salting-houses for the past sixteen years; for the first ten years the vines grew vigorously and yielded pickles until the vines were killed by frost (usually the last of September in this section), yielding from 100,000 to 150,000 per acre, which made them a very profitable crop. During the last six years the yield has been growing less, apparently from some disease unknown to us, the disease spreading and becoming more fatal every year. Last year, 1896, the crop did not pay for the cost of the fertilizer and cultivation. Many large growers have ceased to plant them and unless a remedy had been found the crop must soon have been abandoned here on Long Island.

"Yours truly,

"R. C. COLYER."

SPRAYING MUSKMELONS AND WATERMELONS.

Both muskmelons and watermelons suffer severely from the attacks of downy mildew. There is every reason to believe that Bordeaux mixture, properly applied, will as effectually protect these plants as it does the cucumber. As in the case with the cucumber, the spraying should be commenced when the plants are small and continued at intervals of about ten days until frost. Some of the Bordeaux mixture will, of course, fall upon the melons and spot them, but this will do no harm since the spots can be readily removed. when it is time to market the melons, by rubbing them with a cloth moistened with vinegar.

In this connection it may be of interest to some to know how the unsightly Bordeaux stains can be removed from the hands. In making and applying Bordeaux mixture one can hardly escape staining the hands badly, especially if the potassium ferro-cyanide test is used in making the Bordeaux. By washing the hands in vinegar most of the stain can be removed.

ARE SPRAYED CUCUMBERS AND MELONS POISONOUS?

The question has been asked, may not sprayed cucumbers be poisonous? They who ask this question reason, that, as the cucumber gets its nourishment from the vine which takes its food through the roots and leaves, if the leaves and the soil about the roots are coated with a poisonous substance the plants may absorb the poison and store it in the cucumber. This is an objection which has often been raised against the spraying of plants, but it has been shown to be without foundation. It is true that plants may take up copper compounds from the soil, but not in sufficient quantity to make the fruit poisonous. Likewise, the leaves of land plants under certain conditions can absorb liquids, but only to a very limited extent.

A greater source of danger lies in the Bordeaux mixture which falls on the fruit itself and is eaten with it. However, expert chemists who have made analyses of sprayed grapes and other fruits state that the amount of fruit which it would be necessary to eat in order to get a poisonous dose of Bordeaux mixture is so large that there is no danger. And since copper, the poisonous property of Bordeaux mixture, is not a cumulative poison there is no danger from small doses.

But the most convincing proof that sprayed fruit is not poisonous, is the fact that although the spraying of potatoes, grapes, apples, pears and other fruits is quite a general practice in some parts of our country, no cases of poisoning have resulted therefrom. It will be remembered that when farmers first began to use Paris green for the Colorado potato-beetle there were many people who feared to eat the tubers of the treated plants. Now, Paris green is almost universally used on potatoes without evil consequences to consumers.

Sprayed cucumbers and melons are certainly not poisonous.

THE PREPARATION OF BORDEAUX MIXTURE.

The ingredients used in the preparation of Bordeaux mixture are copper sulphate, fresh lime and water, which are combined in

different proportions for use on different plants. For spraying cucumbers and melons we recommend the use of a mixture containing one pound of copper sulphate, two-thirds of a pound of fresh lime and eight gallons of water. This formula is known as the "1-to-8 formula," which means that each eight gallons of Bordeaux mixture contains one pound of copper sulphate. In a 1-to-11 formula, one pound of copper sulphate is contained in eleven gallons of Bordeaux mixture. and so on. This simple method of designating the strength of Bordeaux mixture was devised by Beach.*

COPPER SULPHATE.

Blue vitriol and blue stone are other names for copper sulphate. It is put on the market in three forms: (1) in large crystals, (2) in granulated form, and (3) in powdered form. The granulated form is the most satisfactory because it is cheaper than the powdered form and dissolves more readily than the large crystals.

Copper sulphate, in quantities of from fifty to one hundred pounds ought not to cost more than five cents per pound. In barrel quantities it can be purchased in New York city for four and one-half cents per pound and perhaps less. Since it will keep indefinitely it is advisable to buy in large quantities in order to get wholesale rates. It is poisonous.

DISSOLVING THE COPPER SULPHATE.

Select a wooden vessel (never use an iron vessel) and put into it a quantity of water equal to about one-half the quantity of Bordeaux mixture desired. A barrel having a capacity of about fifty gallons is excellent for the purpose and, in fact, this is the vessel most generally used. See that the inside of the barrel is free from sticks, dirt or anything else which might clog the nozzles of the spray-pump. Fill the barrel about one-half full of clean water. Weigh out the required amount of copper sulphate, six pounds

*See New York Exp. Sta. Bulletin No. 84, p. 3.

for cucumbers, put it into a loose bag (a fertilizer bag is good) and suspend it in the barrel in such a manner that the copper sulphate will be near the top of the water. If allowed to rest on the bottom of the barrel it will require longer to dissolve.

Preparing the Lime.

Take four pounds or more of the best unslaked lime obtainable (air-slaked lime should not be used), put it into a separate vessel and slake it as for whitewash. It is well to have this vessel of good size so that after the lime is slaked considerable water may be added to dilute and cool it. Formerly, the amount of lime required was determined by weighing, but we now have a chemical test called the potassium ferrocyanide test (to be described presently) which does away with the necessity of weighing the lime.

Mixing the Copper Sulphate and Lime Water.

When the copper sulphate is dissolved and the lime slaked, fasten a fertilizer bag or other coarse cloth over the top of the barrel for a strainer. Have at hand a small bottle containing a little potassium ferrocyanide (yellow prussiate of potash) dissolved in water. Now, strain the lime water into the copper sulphate solution until a considerable quantity has been added. Next, remove the strainer and give the mixture in the barrel a thorough stirring; then add a drop of the potassium ferrocyanide solution. If enough lime has been added no change of color will take place when the drop of potassium ferrocyanide strikes the mixture, but if more lime is needed the drop will change to a reddish brown color. Continue to add lime until the mixture does not change color when tested, being careful to stir thoroughly each time before testing; and after the test shows that there is enough lime add yet a little more lime in order to be *sure* that there is enough. If too little lime is used the plants will be injured in the manner described on page 359, but an excess of lime will do no harm.

Potassium ferrocyanide can be purchased at any drug store. The quantity needed for a season's spraying should cost but a few cents. It is a poison.

Bordeaux mixture must be freshly prepared each time it is needed for use. If allowed to stand longer than a few hours it begins to deteriorate in value.

PREPARING STOCK SOLUTIONS OF COPPER SULPHATE AND LIME.

Where large quantities of Bordeaux mixture are required it will be found advantageous to prepare stock solutions of copper sulphate and lime.

Dissolve one hundred pounds of copper sulphate in fifty gallons of water. Each gallon of the solution will contain two pounds of copper sulphate. When it is desired to prepare Bordeaux mixture, three gallons of this stock solution will be sufficient to make a barrel of the mixture. In this way the time consumed in weighing and dissolving the copper sulphate can be saved. The stock solution can be kept any length of time provided it is kept tightly covered to prevent evaporation.

A stock solution of lime can also be prepared. Lime can be slaked in quantity and kept in a concentrated form if care is taken to keep it covered with water so that it can not harden. When needed for use the required quantity can be taken and diluted to the desired consistency.

SPRAYING MACHINERY.

In the spraying experiment reported in this bulletin the Bordeaux mixture was applied with a knapsack sprayer like the one shown in Fig. 17. The following discussion of knapsack sprayers is copied from Bulletin No. 75 of this Station:

"Knapsack sprayers, as the name indicates, are machines designed to be carried on the back. These are manufactured by a number of firms; the later patterns differ from each other only in small, but occasionally very essential details. In general, knapsacks consist of a copper tank holding from three to five

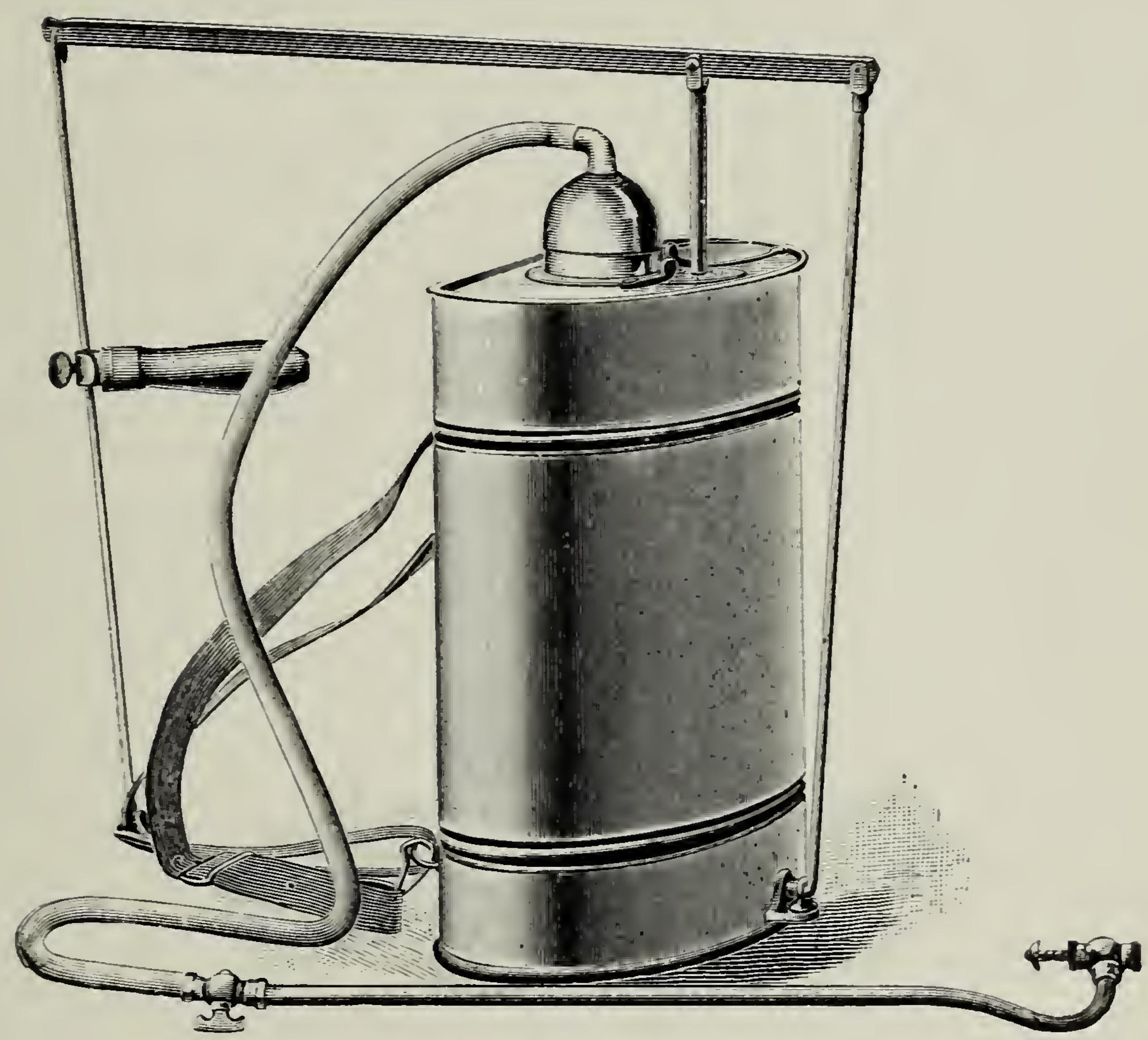


FIG. 17.—KNAPSACK SPRAYER.

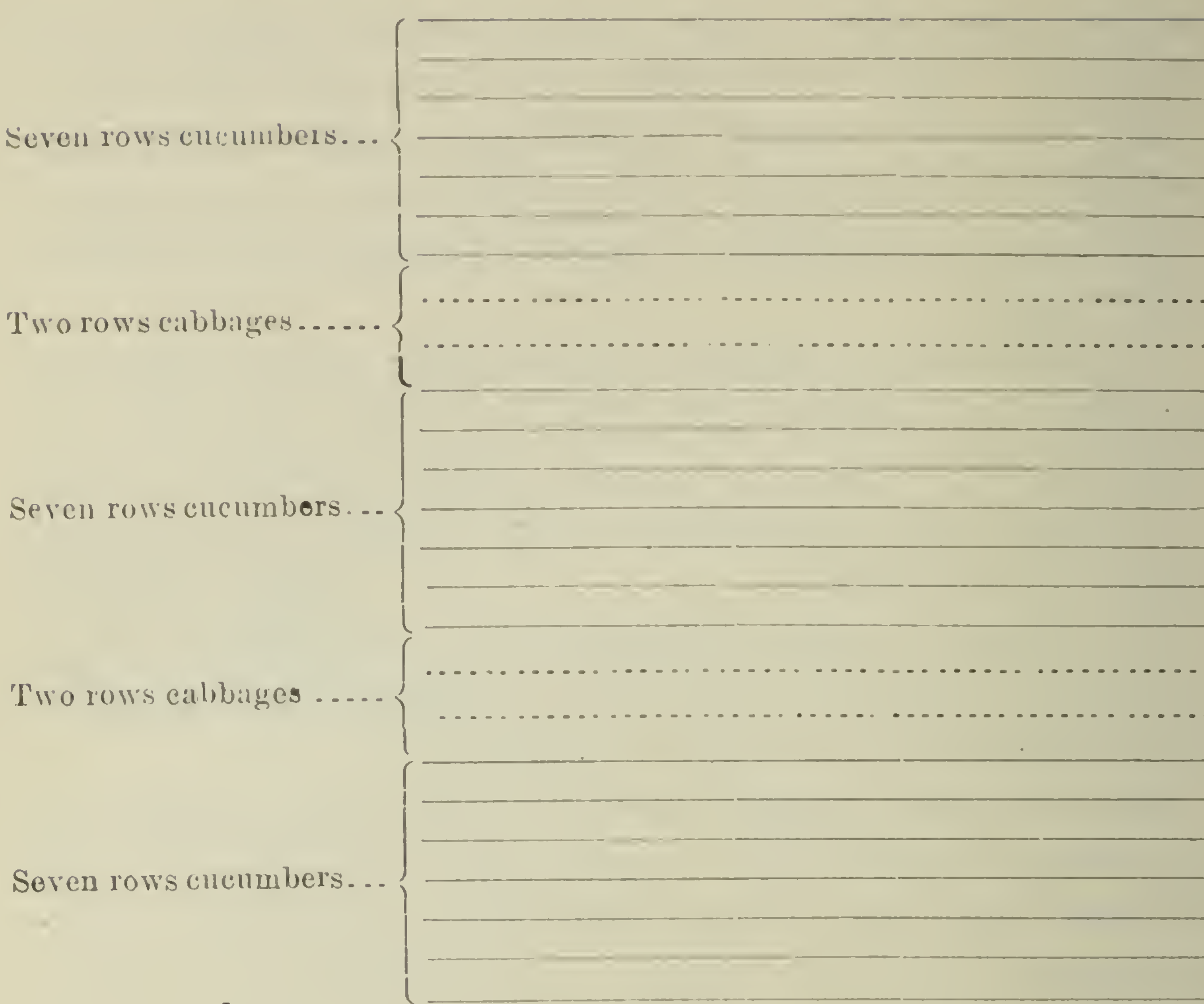
gallons, being held in place on the back by straps over the shoulders. They are furnished with force pumps that have a large air-chamber, making the discharge constant. In the later patterns the pump handle is so arranged that it can be made to work over either shoulder, so that the pumping may be done by either hand.

"In purchasing a knapsack care should be taken to select one in which the discharge pipe enters the tank at the top. If it enters at the bottom it invariably becomes clogged in a short time where heavy mixtures are used, so that it is a constant source of annoyance. . . . . When furnished with a Vermorel nozzle the knapsack is a very efficient sprayer. They can be obtained of most dealers in spraying apparatus at a price ranging from ten to fifteen dollars."

Spraying with a knapsack sprayer is hard work and slow, but the knapsack can be used in a great many cases where it would be inconvenient and perhaps impossible to use either a barrel spray-pump or a power sprayer. On account of the habit of growth of cucumbers and melons, a sprayer on wheels can not be used for spraying these plants except, perhaps, in the manner to be described a little later; hence the knapsack sprayer, in spite of its tediousness, is sure to find favor among those who grow cucumbers and other vines which require spraying. It is so useful for applying fungicides and insecticides to various field and garden plants that every farmer should have one even if he has also a barrel spray-pump.

Some of the large growers insist, however, that an easier and more rapid method should be found. To such persons we make the following suggestions:

Plant the cucumbers in strips of from six to nine rows each, leaving between the strips open spaces of from twelve to thirteen feet in width. In the center of each open space plant two rows of late cabbage, cauliflower, or some other low-growing plant. The following diagram shows the plan of a field planted in this manner:



Buy a good spray-pump (there are several good ones which sell for about ten dollars), mount it in a fifty-gallon barrel and place the barrel on some kind of a cart, which is to be hauled along the open spaces by one horse. The heavy, two-wheeled, dump carts used by market gardeners will answer this purpose very well. The horse walks between the cabbage rows and the wheels which are about six feet apart, run between the cabbages and the outside rows of cucumbers. From the spray-pump let a lead of hose several feet in length extend on either side. At the end of each lead of hose attach a piece of gas-pipe* about eight feet in length and carrying at its extremity two or more spraying nozzles. The two-discharge and three-discharge Vermorel nozzles† are as good as any.

Three men will be required to operate the sprayer—one to drive and work the pump and one on either side to manage the nozzles. A fourth man and a team can, with advantage, be used to haul water and prepare the Bordeaux mixture. If the strips each con-

* What is known as the bamboo extension rod will serve the same purpose admirably.
† For sale by the Gould Manufacturing Co., 16 Murray St., New York City.

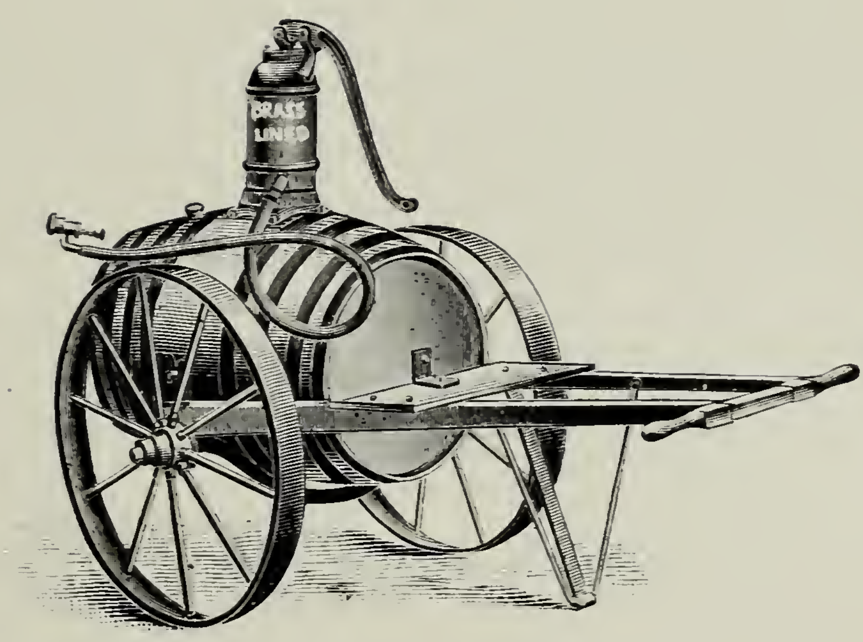


FIG. 18.—SPRAYER ON WHEELS.

tain seven rows (which number seems to us to be the most convenient one, all things considered) five feet apart, it will be necessary for each of the men who carry the nozzles to spray three and one-half rows at each passage. With the aid of the eight feet of gas-pipe they should be able to spray all of the plants on the three and one-half rows without trampling the vines to any extent.

A spraying outfit of this kind will cost from $17 to $20 in addition to the cart. It can be used for spraying potatoes in the same manner as cucumbers.

For the first two or three sprayings, when the plants are small, it is doubtful if this method will be more economical than spraying with a knapsack, but after the plants cover the ground it will probably be found very satisfactory.

If it is desired to omit the cabbage rows and make the open spaces as narrow as possible, a cart of narrow tread will be needed. The Myers' spraying outfit, shown in Fig. 18, has the merit of being very compact. Its tread is but three feet and one-half inch and it can be hauled by one horse or pushed by hand. The capacity of the barrel is forty-five gallons. Price, $25. Manufactured by F. E. Myers & Bro., Ashland, Ohio. For sale by J. S. Woodhouse, 191 Water Street, New York City. We have not tested this sprayer in the field, but it has the appearance of being both durable and effective.

It is not likely that a power sprayer can be used at all.

BRIEF DIRECTIONS FOR SPRAYING CUCUMBERS AND MELONS.

Beginning when the plants are very small, spray thoroughly with the Bordeaux mixture (1-to-8 formula), once every eight or ten days until frost. When heavy rains occur it may be necessary to spray oftener. The leaves should be kept constantly covered with the Bordeaux mixture.

CONCLUSION.

It is, indeed, very gratifying to us to be able to report that a remedy has been found for so destructive a disease as this downy mildew. There are few plants which give such bountiful returns for spraying as do cucumbers. It is to be hoped that farmers

will at once apply the remedy as recommended and thereby make cucumber growing as profitable as it was before the disease appeared; but, judging from the history of the treatment of plant diseases in this country, it seems probable that it will be several years before the spraying of cucumbers will become anything like a general practice. In the meantime those who do spray will reap a harvest, for, in all probability, the disease will continue to spread and become so destructive as to drive many growers out of the business, and thus keep up prices. While, in any given locality, the disease may fluctuate in virulence from year to year with the weather conditions, it is undoubtedly in America to stay and may be expected to cause heavy losses in every year.

EXPLANATION OF PLATE XI.

Fig. 1. Cross-section of a cucumber leaf.

a. Epidermis of the upper surface.

a'. Epidermis of the under surface.

b.b. Palisade cells.

c. A chlorophyll grain.

m. Cross-section of a stoma.

i. Intercellular passage.

Fig. 2. Surface section from the under surface of a cucumber leaf.

s. A stoma.

r. The rift or opening between the two crescent-shaped guard-cells of the stoma.

Fig. 3. A plant hair (trichome) from the under surface of a cucumber leaf.

NOTE.—All the figures on this plate were drawn with the aid of an Abbé camerá lucida under a magnification of 700 diameters and afterwards reduced by the engraver to the present magnification, viz.: 465 diameters.

EXPLANATION OF PLATE XII.

The cucumber downy mildew (*Plasmopara cubensis*).

Fig. 1. A vigorous sporophore grown on a cucumber leaf which had been kept twenty-four hours in a moist chamber. (Original.)

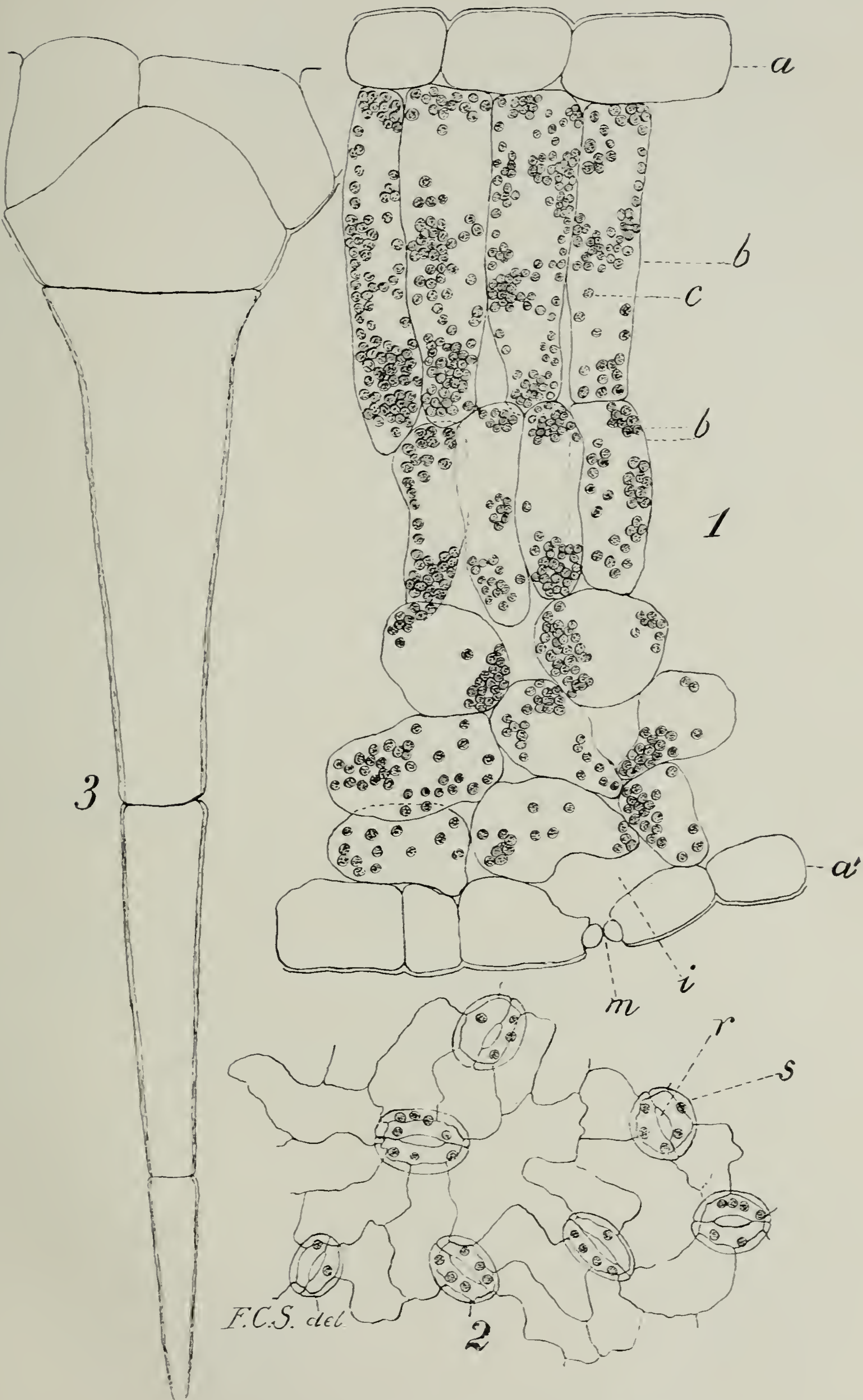


PLATE XI.—THE STRUCTURE OF A CUCUMBER LEAF.

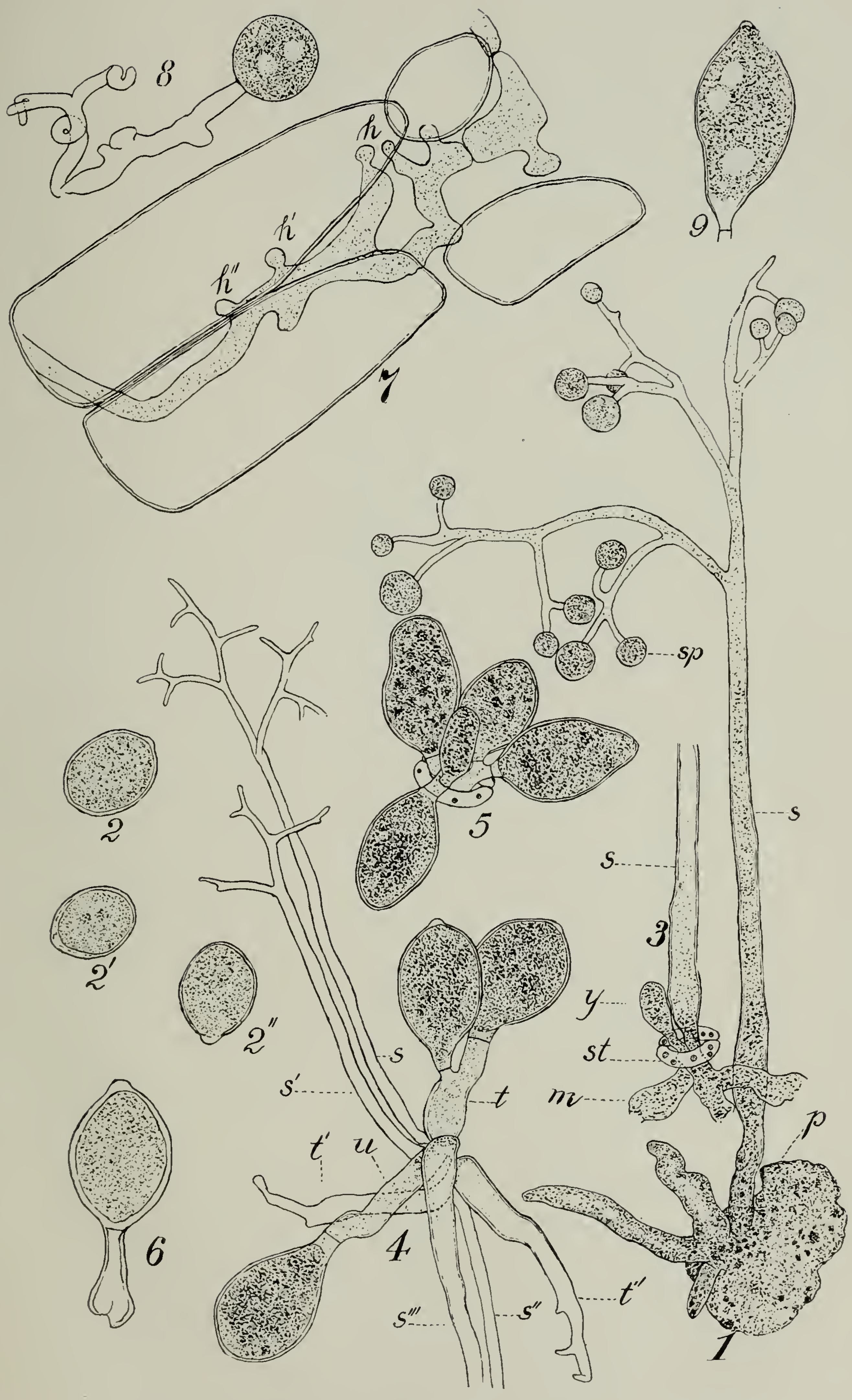


PLATE XII.—THE DOWNY MILDEW FUNGUS (*Plasmopara cubensis*).

PLATE XIII.—VIEW OF A PORTION OF THE EXPERIMENTAL FIELD AT WOODBURY. TAKEN AUGUST 27.

s. The sporophore proper.

sp. Immature spore.

p. Mass of protoplasm.

Figs 2, 2′ and 2″. Mature spores of the ordinary normal form. (Original.)

Fig. 3. Shows how the sporophores come out through the stomata. (Original.)

s. Portion of a mature sporophore.

y. A young sporophore.

st. The stoma.

m. A fragment of the mycelium.

Fig. 4. A cluster of sporophores taken in dry weather from a cucumber leaf grown out of doors. (Original.)

s, s', s'', s'''. Four stunted sporophores of the normal branched form.

u. An abnormal unbranched sporophore bearing a monstrous spore.

t, t', t''. Transition forms between *s* and *u.*

Fig. 5. A cluster of very short-stalked spores from a cucumber leaf. (Original.)

Fig. 6. A short-stalked spore from a muskmelon leaf. (Original.)

Fig. 7. Four cells of a cucumber leaf with the mycelial threads of the fungus running between them and sending into them the haustoria (h, h', h''). (Copied after Humphrey in 8th Ann. Rept. Mass. Exp. Sta.)

Fig. 8. A rare form of short-stalked spore from a cucumber leaf. (Original.)

Fig. 9. A monstrous pear-shaped spore which was found attached to a well-developed sporophore after the manner of the ordinary spores. Two other spores of this character have been observed. (Original.)

Note.—All figures on this plate are equally magnified, viz.: 465 diameters; and with the exception of Fig. 7 all were drawn with the aid of an Abbé camera lucida in the same manner as the figures on Plate XI.

II. SPRAYING POTATOES ON LONG ISLAND IN THE SEASON OF 1896.*

F. C. STEWART.

SUMMARY.

(1) Potatoes on Long Island in 1896 were unusually free from disease. In spite of this fact, spraying five times with Bordeaux mixture increased the yield on Victor Rose 4¾ bushels, on White Elephant 60½ bushels, on Green Mountain 62 bushels, on Defender 16 bushels, and on Late Blush 28 bushels per acre.

(2) The total expense of spraying 8.58 acres of potatoes five times, including all labor and cost of chemicals and an allowance for the wear of machinery, was $34.25, or $4 per acre.

(3) The expense of applying Paris green twice to 1.09 acres of potatoes, by means of the Leggett powder-gun, was $1.65, or $1.51 per acre.

(4) Comparing the value of the increase in yield due to spraying, with the outlay required to produce that increase, it was found that spraying had been profitable on all varieties except Victor Rose. On the variety Green Mountain there was a net profit of $13 per acre, allowing potatoes to be worth 25 cents per bushel. Spraying, being profitable in such a season as 1896, must be profitable in almost any season on Long Island.

(5) Fungiroid, applied dry, was found to be so much inferior to the wet Bordeaux mixture that its use as a substitute for Bordeaux mixture is not to be recommended.

(6) The "Lion Brand" Bordeaux mixture, likewise, proved to be of practically no value.

(7) Bordeaux mixture (1-to-7 formula) used without any Paris green, gave considerable protection against insects but not enough to warrant the recommendation of its use. Paris green should always be added to the Bordeaux mixture whenever either flea-beetles or Colorado potato-beetles are numerous.

*Reprint of Bulletin No. 123.

(8) It appears that three applications of Bordeaux mixture are not sufficient for potatoes on Long Island. In the early part of the season it is necessary to fight flea-beetles and Colorado beetles, in midsummer the early blight must be kept in check, and in the latter part of the season late blight and flea-beetles make their appearance. The plants need protection throughout the season.

(9) One-to-eleven Bordeaux gave slightly better results than 1-to-7 Bordeaux. As a repellent of insects the weak mixture seems to be fully as effective as the stronger mixture. Had blight been prevalent the results might have been different. The use of the weak mixture cannot be recommended without further trial.

(10) Plants sprayed five times with Bordeaux mixture at the rate of 100 gallons per acre, yielded in one case 15 bushels per acre and in another case 27 bushels per acre more than plants sprayed at the rate of 50 gallons per acre.

(11) A trial of the Hudson Special Bordeaux Sprayer showed it to be an efficient sprayer for applying Bordeaux mixture to potatoes.

INTRODUCTION.

It is a well-known fact that the ravages of the late blight or rot blight (*Phytophthora infestans*) of the potato can be prevented by spraying the plants with Bordeaux mixture. Many carefully conducted experiments have been made, both in this country and in Europe, and in almost every one of these experiments the late blight and potato rot have been successfully controlled by spraying. The amount of evidence is so great that we are obliged to accept it as an established fact that late blight can be prevented by spraying.

The disease makes its appearance in midsummer during warm, moist weather and rapidly destroys the plants, whole fields sometimes being ruined in the space of three or four days. At digging time many of the tubers are found to be rotten. Spraying should be commenced before the disease makes it appearance and two or three applications made at intervals of about two weeks. In cases where the disease has been severe this treat-

ment has sometimes saved almost an entire crop at an expense of two or three dollars per acre, which shows that, at times, spraying is exceedingly profitable. It is quite generally conceded that it will pay to spray potatoes in those seasons in which late blight occurs.

The late blight, however, does not occur every season. In some portions of the United States it never occurs. On Long Island it probably occurs destructively about one year in four, on the average. Now, spraying is preventive, not curative, and so must be commenced before it is known whether the disease will appear. Accordingly, farmers have come to look upon spraying as a form of insurance, and some have raised the question, "Can we not better afford to lose a crop occasionally than to bear the expense of spraying every season?" Those who ask this question assume that spraying is of no value except to prevent the late blight. But that is not true; spraying benefits the potato plant in other ways:

(1) Spraying protects it against the attacks of early blight (*Macrosporium solani*), a disease which attacks the leaves, producing circular or elliptical, dead, brittle spots which are marked with dark colored rings arranged concentrically, like the rings on the ball of the thumb. This disease is not as conspicuous as the late blight but, on the whole, is perhaps fully as destructive since it is more widely distributed and occurs to some extent every season.

(2) Spraying, if done thoroughly, will prevent the greater part of the damage done by flea-beetles (*Crepidodera* [*Epitrix*] *cucumeris*).

(3) The plants can be more completely protected against the attacks of Colorado potato-beetles (*Doryphora decemlineata*), than is possible by any method in which Paris green is used alone.

(4) The danger of injury to the foliage from Paris green poisoning is avoided.

(5) Some of the best authorities on the spraying of plants hold that Bordeaux mixture has a beneficial influence on potato foliage even when no insects or diseases are present. The nature of this influence has not yet been satisfactorily explained.

All of the above-mentioned advantages of spraying must be taken into consideration when discussing the question, Will it pay to spray every season?

In most of the recorded experiments on potato spraying, the late blight has been an important factor, and hence these experiments do not furnish a complete answer to the present question. It is necessary to know not only the benefit to be derived from spraying in seasons when late blight is prevalent, but also the benefit to be derived from spraying in seasons when there is *no* late blight. Fortunately, the conditions have been such that our experiments on Long Island during the past two seasons have thrown considerable light on this very point.

SPRAYING EXPERIMENT AT FLORAL PARK.

In 1895 we made a spraying experiment* at Floral Park, Long Island. A field of potatoes containing four and one-half acres was divided into three equal plats. One plat was sprayed five times with Bordeaux mixture, one plat was sprayed three times with Bordeaux mixture and the remaining plat was not sprayed. With the exception of spraying, the three plats were treated as nearly alike as was possible in every respect. The Colorado potato-beetles were kept under control by the use of Paris green. On the sprayed plats the Paris green was applied with the Bordeaux mixture in the first two applications. On the unsprayed plat the same quantity of Paris green was used and was applied in water by means of the spraying machine at the same time the sprayed plats were treated the first two times.

Throughout the entire season there was no trace of late blight, even on the unsprayed plat, and so it might be thought that our spraying had been unnecessary. But the early blight had been prevalent and there had also been some flea-beetles on the unsprayed plat. Spraying with Bordeaux mixture had prevented these enemies from doing much damage to the sprayed plats and as a consequence these plats gave a considerably larger yield than the unsprayed plat. The plat sprayed three times yielded 52 bushels of merchantable tubers per acre more than the un-

*For the details of this experiment see N. Y. Agrl. Exp. Sta. Bul. No. 101, pp. 73-76.

sprayed plat. and the plat which had been sprayed five times yielded 62 bushels per acre more than the unsprayed plat. No record was kept of the expense of the spraying but there was certainly considerable profit.

FIRST SPRAYING EXPERIMENT AT EAST WILLISTON.

There being a demand for some definite information as to the expense of spraying potatoes on Long Island, the Station, in 1896, undertook an experiment along this line. The season was remarkably favorable for the potato crop, as very little disease of any kind appeared. This fact made our results exceptionally valuable since they show what spraying will do for potato plants which are apparently healthy.

From Mr. R. H. Robbins, we obtained the privilege of using for the experiment a potato field containing about nine and two-thirds acres on his farm near East Williston, Long Island. The field was in the form of a parallelogram, 48 rods long and about 32 rods wide, the rows running the short way. The soil was practically uniform and had been fertilized alike all over the field. In 1895 the entire field was planted to cabbage. In 1896 four varieties of potatoes were planted — 64 rows of Victor Rose, 93 rows of White Elephant, 53 rows of Green Mountain and 73 rows of Defender. Care was taken that the field should receive the same cultivation throughout.

Each variety was divided into two plats, one of which was sprayed with Bordeaux mixture five times according to the approved method, and the other was not treated at all, except that Paris green was applied twice with Leggett's powder-gun according to the common practice of Long Island farmers. At the close of the season the potatoes on these two plats were dug and weighed separately.

The accompanying diagram shows the relative size and position of the sprayed and unsprayed portions of the field.

How the spraying was done.— It being desired to ascertain the expense of spraying potatoes as it should be practiced by the average grower of late potatoes on Long Island, every part of the work was put upon a practical basis. All of the methods used

PLATE XIV.—THE SPRAYING OUTFIT USED IN THE EXPERIMENT AT EAST WILLISTON.

were such as we would recommend for actual farm practice. We sprayed five times* with Bordeaux mixture, 1-to-8 formula, commencing when the plants were about six inches high and repeating the treatment at intervals of about two weeks. Whenever Colorado potato-beetles or flea-beetles became numerous, Paris green was added to the Bordeaux mixture at the rate of three-fourths of a pound of Paris green to 50 gallons of the Bordeaux mixture. The copper sulphate was purchased directly from the manufacturer in New York in quantity (450-pound-barrel), at 4½ cents per pound. The spraying outfit used is shown in Plate XIV. It consisted of an Eclipse No. 2 spray-pump† mounted in a 70-gallon barrel which was put on a stout two-wheeled cart‡ having wheels five feet eight inches apart and hauled by one horse. By means of a rubber hose the spray-pump communicated with a three-fourths-inch iron pipe to which were attached eight Deming-Vermorel nozzles, arranged in such a manner that each of

*The dates of spraying were June 4, June 19, July 2, July 17 and July 31.

†Manufactured by Morrill & Morley, Benton Harbor, Mich.

‡The cart and barrel were obtained from a Callister Paris green sprinkler, manufactured and sold by Thomas Callister, Queens, N. Y. Many Long Island farmers are familiar with this sprinkler. An ordinary 50-gallon barrel will answer the purpose just as well except that it will require filling oftener. Any stout two-wheeled cart having a tread of about six feet can be used. A two-wheeled dump-cart will answer the purpose.

Victor Rose.—56 rows; sprayed.
1.9382 acres.

Victor Rose.—8 rows; not sprayed. 0.2758 acres.

White Elephant.—84 rows; sprayed.
2.8817 acres.

White Elephant.—9 rows; not sprayed. 0.3073 acres.

Green Mountain.—48 rows; sprayed.
1.6318 acres.

Green Mountain.—5 rows; not sprayed. 0.1694 acres.

Defender.—63 rows; sprayed.
2.1261 acres.

Defender.—10 rows; not sprayed. 0.3358 acres.

Diagram of Experiment Field at East Williston.

four rows received the spray from two nozzles. Thus, four rows were sprayed at each passage. One man (an ordinary farm laborer) worked the pump and did the driving. This same man prepared the Bordeaux mixture and did all work connected with the spraying. The water used in the Bordeaux mixture was obtained at a farm-house which was 40 rods from the nearest point of the field. Therefore, it was necessary to haul the water from 40 to 88 rods. The Bordeaux mixture was prepared at the farmhouse and taken to the field in the spray-barrel.

Expense of the spraying.—The items of expense are as follows:

240 pounds copper sulphate at 4½ cents per pound	$10 80
Freight on 240 pounds copper sulphate	25
1 barrel unslaked lime	1 40
Carting sulphate and lime from railroad station	50
Potassium ferrocyanide	10
25 pounds Paris green at 20 cents per pound	5 00
44 hours labor for man at 15 cents per hour	6 60
44 hours labor for horse at 15 cents per hour	6 60
Total	$31 25

This $31.25 covers all labor and cost of chemicals but does not include any allowance for the wear of machinery. The latter, however, is a part of the necessary expense of spraying and must be taken into consideration; but the amount can only be estimated. Considering that the first cost of the spraying outfit, exclusive of the cart, was less than $25, and that it was in use only about one-tenth of the time it might have been used, it would seem that $3 is sufficient to allow for the wear of the machine. Three dollars added to $31.25 (cost of labor and chemicals) makes *the total expense of spraying 8.58 acres, $34.25; or the total expense of spraying one acre five times, $4; or the total expense per acre for each spraying, 80 cents.*

Any farmer can spray potatoes as cheaply as this, provided he goes about it in the right way and is not obliged to haul water too far. The ease with which water can be obtained has an important bearing on the expense of spraying. Where water can be obtained easily and does not require hauling more than a few

rods, spraying can be done for less than $4 per acre. In our experiment the water was pumped by hand and hauled from 40 to 88 rods, which consumed considerable time. We have also placed the value of labor, for both man and horse, a trifle high. Thirty cents per hour or three dollars per day for a man and horse is more than they will cost the average farmer.

The total quantity of Bordeaux mixture used in the experiment was 1,975 gallons, or 46 gallons per acre for each application. The quantity of Bordeaux mixture required depends largely upon the kind of nozzle used. The nozzle should throw a mist-like spray, the finer the better. Nozzles which throw a coarse spray waste the Bordeaux mixture. Deming-Vermorel nozzles were used in the experiment.

Treatment of the unsprayed plats.—As previously stated, a few rows of each variety were left unsprayed in order that the benefit from spraying might be definitely determined by comparing the yield of the sprayed plat with the yield of the unsprayed plat. These unsprayed plats were treated as the average farmer would treat his crop.

On Long Island it has become very popular to combat the Colorado potato-beetles with Paris green applied dry by means of Leggett's powder-gun. The Paris green is diluted with a considerable quantity of flower or air-slaked lime, preferably the latter, since the lime prevents the Paris green from "burning" the foliage. So we planned to treat the unsprayed or check plats in this manner.

The owner of the field was asked to notify us when he thought it was necessary to begin fighting the Colorado potato-beetles. On June 26 he notified us that the potato beetles were beginning to do damage to the unsprayed plats and should be poisoned. The same day we applied Paris green with Leggett's powder-gun under what we considered favorable circumstances. On the 1.09 acres there were used 1.5 pounds of Paris green mixed with 13 pounds of air-slaked lime. There was very little wind and the morning had been misty so that the foliage was wet. The Paris green and lime adhered well to the foliage and most of the beetles were killed.

On July 11 it was thought necessary to apply Paris green again. This time three pounds of Paris green were applied with lime in the same manner as before. The day, however, was not so suitable for the work. There was no wind but the foliage was dry. Most of the beetles were killed and they did not again become sufficiently numerous to seem to require another treatment.

The expense of treating the 1.09 acres with Paris green was as follows:

4½ pounds Paris green at 20 cents per pound	$0 90
5 hours labor at 15 cents per hour	75
Total	$1 65

This makes the expense per acre $1.51, which is undoubtedly somewhat greater than it is in ordinary farm practice. The powder-gun was rusty and did not work well, which resulted in a loss of time and waste of Paris green.

The results.—In the case of each of the four varieties the sprayed plat and the unsprayed plat were dug and weighed separately. The product of each plat was also divided into "merchantable tubers" and "culls," the latter class including not only the small tubers but also those which had been mutilated by the potato digger. The accompanying table presents the results in a condensed form:

EFFECT OF SPRAYING WITH BORDEAUX MIXTURE UPON YIELD OF POTATOES.

VARIETY AND TREATMENT.		Yield per Acre.						Increase in total yield per acre due to spraying.		Increase in yield of merchantable tubers per acre due to spraying.	
		Merchantable.		Culls.		Total.					
		Bu.	Lbs.	Bu.	Lbs.	Bu.	Lbs.	Bu.	Lbs.	Bu.	Lbs.
Victor Rose	Sprayed	167	17	15	44	183	1	10	55	4	47
	Unsprayed	162	30	9	36	172	6	....		....	
White Elephant	Sprayed	185	21	14	49	200	10	63	31	60	34
	Unsprayed.	124	47	11	52	136	39	....		....	
Green Mountain	Sprayed	253	38	13	21	266	59	63	50	62	5
	Unsprayed.	191	33	11	36	203	9	....		....	
Defender	Sprayed	194	29	8	47	203	16	19	14	16	6
	Unsprayed	178	23	5	39	184	2	....		....	

No trace of late blight appeared in any part of the field. There was some early blight on the unsprayed plats but not as much as usual. The average observer would have said that the plants on the unsprayed plats were free from disease throughout the season and that it would certainly have been a wase of labor to spray them. Flea-beetles and Colorado potato-beetles were abundant.

In spite of the fact that the plants appeared to be free from disease of all kinds, spraying increased the yield sufficiently to pay all of the expense of spraying and a fair profit besides. The fact must not be overlooked that had these potatoes not been sprayed, Paris green must have been applied to them with a powder-gun or in some other way to keep the Colorado potato-beetles in check. Practically speaking then, the expense of spraying is not $4 per acre but $4 minus the expense of applying Paris green alone, which, in the experiment, was $1.51. We admit that $1.51 is probably high but in the absence of more accurate information we are obliged to use this sum. The difference between $4 and $1.51 is $2.49 which is the amount of extra expense per acre caused by spraying.

By consulting the table it may be seen that spraying increased the yield of merchantable tubers per acre on the four varieties as follows:

Victor Rose, 4 bushels and 47 pounds; value at 25 cents per bushel.	$1.19
White Elephant, 60 bushels and 34 pounds; value at 25 cents per bushel	15 14
Green Mountain, 62 bushels and 5 pounds; value at 25 cents per bushel	15 52
Defender, 16 bushels and 6 pounds; value at 25 cents per bushel...	4 02

Comparing the values in the last column with $2.49, the expense of producing them, it is seen that:

Spraying Victor Rose resulted in a loss of..............	$1 30 per acre.
Spraying White Elephant resulted in a profit of.........	12 65 per acre.
Spraying Green Mountain resulted in a profit of.........	13 03 per acre.
Spraying Defender resulted in a profit of...............	1 53 per acre.

Even if the comparison is made with $4, the total expense of spraying, there will still be a profit on all the varieties except Victor Rose—$2.81 loss on Victor Rose, $11.14 profit on White Elephant, $11.52 profit on Green Mountain and 2 cents profit on Defender.

The results of this experiment tend to show that it will pay to spray potatoes on Long Island every season; for if it has been profitable the past season it will be profitable any season. The season of 1896 was certainly an unusually favorable one for potatoes on Long Island. It is rare that potato plants are so generally free from the various blights.

THE REQUISITES OF A POTATO SPRAYING EXPERIMENT.

The spraying of potatoes has never been practiced to any great extent on Long Island. Last year several farmers tried it for the first time and on account of the lack of blight they failed to obtain the striking results which they had expected. They saw no marked contrast between their fields which had been sprayed and their neighbors' fields which had not been sprayed. In some cases the unsprayed fields made the better appearance. Some of the more careful ones took the precaution to leave an unsprayed strip through the center or along one side of the sprayed field in order to make the test a fair one. They who did this must have observed a difference between the sprayed and unsprayed plants, but probably considered the difference so slight as to be of no practical importance. Had they completed the experiment by carefully measuring the land and measuring the potatoes on the sprayed and unsprayed portions of the field they would, most likely, have been astonished. A difference of from 15 to 20 bushels per acre can scarcely be detected while the crop is growing or even after the tubers have been thrown out by the potato digger, and yet this quantity is ordinarily sufficient to pay the expense of spraying.

To those persons who doubt that spraying pays, we suggest that they give it a fair test. A fair test requires that care be taken to avoid all unnecessary expense and that the sprayed and unsprayed plants shall be under practically the same conditions.

They must be of the same variety, planted at the same time, in the same manner, on the same kind of soil, treated with the same kind and quantity of fertilizer and given the same cultivation. The spraying must be properly done, the land accurately measured and the crop weighed. Failure to comply with any one of these conditions makes the test an unfair one.

THE PHILOSOPHY OF SPRAYING.

It is believed that, in some unexplained way, the Bordeaux mixture has a direct beneficial influence on potato foliage, in addition to its value as a fungicide and repellent to insects. Its chief value, however, lies in the protection which it affords the leaves against the attacks of parasitic fungi and insects. The leaves of the potato plant are very essential organs and it is of the greatest importance that they should be perfect in order that they may do their work properly. The inorganic food substances which the plant absorbs from the soil through its roots are transferred to the leaves and by them assimilated, or in other words, transformed into starch and certain other organic substances which pass down the stem and are stored up in the tubers. The size and quality of the tubers are, therefore, directly dependent upon the activity of the leaves. If portions of the leaves are eaten away by insects or destroyed by disease their capacity for assimilation is lessened and the tubers are correspondingly smaller.

The truth of this is recognized when there is great destruction of foliage such as is caused by a severe attack of late blight or by hordes of Colorado potato-beetles, but it seems certain that the amount of damage done by leaf-eating insects and parasitic fungi is greatly underestimated. This is proven by the results of the spraying experiment reported in the previous pages. In that case, spraying increased the yield on one variety by the amount of 62 bushels per acre, chiefly by protecting the leaves in the following three ways: (1) from the apparently slight injury of the early blight fungus; (2) by affording partial protection from the injury caused by flea-beetles; and (3) by preventing the attacks of Colorado potato-beetles more thoroughly than could

be done by means of Paris green applied with a powder-gun. No one of these three kinds of injury appeared great but the sum of the three was sufficient to make spraying very profitable.

The fungi which cause the diseases early blight and late blight, propagate themselves by means of minute spores which may be carried from plant to plant by the wind. When one of these spores falls upon a potato leaf and finds there a drop of dew or other moisture it germinates and grows into the leaf, producing a new disease-spot. If the leaf is covered with a thin coating of Bordeaux mixture the spore is unable to germinate and in this way spraying prevents fungous diseases. It is evident that any leaf which has none of the Bordeaux mixture will not be protected.

Bordeaux mixture will not kill either flea-beetles or Colorado potato-beetles, but it is very distasteful to them. They will not feed upon leaves covered with Bordeaux mixture if they can avoid it; and when Paris green is added to the Bordeaux mixture we have the best known remedy for both these insects. The Bordeaux mixture, being very adhesive, holds the Paris green on the leaves through quite heavy rains which would wash off Paris green applied in any other way. For flea-beetles, Paris green applied by the ordinary methods seems to be almost without avail. It is a mistaken notion, however, that Paris green is not poisonous to flea-beetles. It certainly will kill them if they eat it, and it is probably that a goodly number of them are actually killed by the Paris green applied in the ordinary way for potato-beetles. But flea-beetles are very cautious insects and shun the poison. If the Paris green is mixed with Bordeaux mixture and applied in the form of a fine spray, the poison will reach nearly every leaf and stick there for a long time, keeping the flea-beetles at bay.

From this discussion it will be seen that the degree of success attained in fighting flea-beetles by spraying depends upon the thoroughness with which the spraying is done. Leaves which are kept well covered with Bordeaux mixture and Paris green will suffer very little from flea-beetle attacks. Such leaves will suffer slightly from attacks made on the undersides, for flea-

beetles feed to some extent from the under sides of the leaves where it is difficult to reach them with Bordeaux mixture. But all leaves which do not receive the Bordeaux mixture will be attacked by flea-beetles and also by fungi. In spraying, then, care must be taken that each and every leaf receives a little of the Bordeaux mixture. With a knapsack sprayer this is easily accomplished. There is no danger of getting on too much—the more the better. Where the spraying is done with stationary nozzles it is more difficult to reach all of the leaves. Experience has shown that one nozzle per row (no matter of what kind the nozzle may be) is insufficient. Two good nozzles per row will cover the foliage fairly well.

While it is impossible to state with accuracy what degree of protection against flea-beetles will be afforded by Bordeaux mixture and Paris green applied every two weeks by means of two stationary nozzles per row, observation leads us to estimate it at from 25 to 50 per cent ; that is, plants sprayed in this way would be injured by flea-beetles from one-half to three-fourths as much as plants not sprayed. In view of the results of the experiment reported on page 397 of this Report, we are of the opinion that it will pay to use three nozzles per row in the last two sprayings.

SECOND SPRAYING EXPERIMENT AT EAST WILLISTON.

The following spraying experiment was made in the season of 1896 on a farm managed by C. Burkard and located near East Williston, N. Y.

Objects of the experiment.—The experiment was designed to furnish information on several points of interest in regard to the spraying of potatoes.

During the past two years the Station has received numerous inquiries concerning the value of the so-called dry Bordeaux mixture patented under the name "Fungiroid." This is manufactured and sold by Leggett & Brother, 301 Pearl Street, New York. It is claimed to be a remedy for potato blight and some other fungous diseases and is to be applied in dry form with a powder-gun sold by the same firm. The powder-gun is much used by Long Island farmers for applying Paris green to potatoes and the

question is often asked, Will not the Fungiroid and Paris green applied together with the powder-gun produce as good results as the wet Bordeaux mixture applied with a spraying machine? An answer to this question was one of the objects of the experiment.

James A. Blanchard, 4 and 6 Gold Street, New York, has patented and placed upon the market a concentrated form of Bordeaux mixture, which is known as the "Lion Brand" Bordeaux mixture. It is sold in tin cans containing one gallon of a thick, slate colored liquid. This quantity is to be added to forty-nine gallons of water and applied with a spraying machine in the ordinary way. This mixture also was tested in the experiment.

In some sections of the United States three applications of Bordeaux mixture to potatoes are considered sufficient. In other sections it seems necessary to make five applications. In our experiment at Floral Park, in 1895, one plat was sprayed three times and another five times, the first three applications on the two plats being made on the same dates. The plat sprayed five times yielded ten bushels per acre more than the plat sprayed three times. It was thought that the three sprayings might have given better results if they had been made at sufficiently long intervals to cover the entire season of growth. It was planned to test this in the experiment.

The Bordeaux mixture used for spraying orchards and vineyards is made after the 1-to-11 formula, in which one pound of copper sulphate is required to make eleven gallons of Bordeaux mixture. But for spraying potatoes a more concentrated form of Bordeaux mixture has generally been used; namely, Bordeaux mixture made after the 1-to-7 formula, in which one pound of copper sulphate is required to make seven gallons. The weaker mixture is, of course, the cheaper and consequently the more desirable to use provided it is equally efficient. To determine the relative efficiency of these two strengths of Bordeaux mixture was one of the objects of the experiment.

In the experiment at Floral Park, in 1895, it was observed that Colorado potato-beetles shunned plants which had been sprayed

with Bordeaux mixture containing no Paris green.* This suggested the idea that perhaps Paris green might be dispensed with and the Bordeaux mixture alone used for both "bugs" and blight. The experiment was planned to test the value of Bordeaux mixture used without Paris green.

Plan of the experiment.—In an experiment in which the character of the soil is an important factor, long narrow plats are likely to give more reliable results than square plats or plats in which the length and breadth are nearly equal. The narrower the plats the less is the liability to error arising from non-uniformity of soil. The experiment under consideration was so planned that differences in soil conditions were practically eliminated and this adds much to the value of the results.

The experiment included fourteen rows, 920 feet, or nearly fifty-six rods in length, of the variety Late Blush.

The rows were numbered consecutively and two separated rows received similar treatment in each case.

Rows 1 and 8 were treated five times with Fungiroid and Paris green, half and half, applied dry with a Leggett powder-gun according to the directions given on the can.†

Rows 2 and 9 were treated five times with Paris green in lime water. The lime water was used to prevent the free arsenious acid in the Paris green from injuring the foliage.

Rows 3 and 10 were sprayed five times—the first time with Paris green in lime water the same as was used on rows 2 and 9, and the last four times with "Lion Brand" Bordeaux mixture‡ and Paris green.

Rows 4 and 11 were sprayed four times with Bordeaux mixture (1-to-7 formula) and Paris green. It was the original intention to spray these rows only three times, but it was found absolutely necessary to make a fourth application.

---

*N. Y. Agrl. Exp. Sta. Bul. No. 101, p. 75.

† Fungiroid may be purchased separately or mixed with Paris green, half and half, in pound cans ready for use. We used the latter form.

‡ It was planned to use "Lion Brand" Bordeaux mixture for all five applications but the can of Bordeaux designed for use in the first application was stolen. The contents in one of the two cans subsequently used was so thick that it could not be gotten out of the can through the three-fourths inch hole provided for that purpose. It was necessary to cut out the top of the can. The other can was better in this respect, but still it was difficult to empty out the contents through the hole.

Rows 5 and 12 were sprayed five times with Bordeaux mixture (1-to-7 formula) and Paris green.

Rows 6 and 13 were sprayed five times with Bordeaux mixture (1-to-7 formula) alone.

Rows 7 and 14 were sprayed five times with Bordeaux mixture (1-to-11 formula) and Paris green.

The several applications were made to all fourteen rows on the same dates, namely, June 11, June 26, July 10, July 24 and August 7. The last application was omitted from Rows 4 and 11. All liquids were applied with a knapsack sprayer and care was taken that each row received practically the same quantity. In all cases where Paris green was used (except on Rows 1 and 8), it was used at the rate of one ounce of Paris green to four gallons of liquid. The first application was made when the plants were about six inches high.

Prevalence of insects and disease.—No trace of late blight appeared and only a small amount of early blight. Flea-beetles were moderately abundant and Colorado potato-beetles very abundant. For a few days after the first treatment, June 11, the potato-beetles were scarce, but by the time of the second treat-

COMPARATIVE EFFECT OF DIFFERENT FUNGICIDES AND INSECTICIDES UPON YIELD OF POTATOES.

KIND OF TREATMENT RECEIVED.	PRODUCT OF THE TWO ROWS.		COMPUTED YIELD PER ACRE.			Increase in yield of merchantable tubers per acre using the two rows treated with Paris green in lime-water as a basis of comparison.
	Merchantable tubers.	Culls.	Merchantable tubers.	Culls.	Total.	
	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.
Fungiroid and Paris green, 5 times	7.25	3.00	62.50	25.75	88.25	— 6.25
Paris green in lime-water, 5 times	8.00	2.50	68.75	21.50	90.25	
Paris green in lime-water, once; "Lion Brand" Bordeaux + Paris green, 4 times	8.38	1.75	72.25	15.00	87.25	+ 3.50
1-to-7 Bordeaux + Paris green, 4 times	10.63	1.50	91.50	12.75	103.25	+ 22.75
1-to-7 Bordeaux + Paris green, 5 times	11.00	1.25	94.75	10.75	105.50	+ 26
1-to-7 Bordeaux, 5 times	8.75	1.50	72.25	13.00	88.25	+ 6 50
1-to-11 Bordeaux + Paris green, 5 times	11.25	1.00	97.00	8.50	105.50	+ 28.25

ment, June 26, they were again abundant. The second treatment disposed of them again, but they became numerous by the time of the third treatment, July 24. The third treatment, however, finished them for the season. They gave no trouble after July 24. In this experiment the fight was chiefly against the Colorado potato-beetles, and it was a hard fight. Throughout the whole season it was noticed that they were the most numerous on Rows 1 and 8, treated with Fungiroid and Paris green. Rows 2 and 9 seemed to suffer to about the same extent as Rows 3 and 10. The rows to which ordinary Bordeaux mixture had been applied did not suffer nearly so much as the other rows, and among the Bordeaux rows it was noticeable that the beetles had a decided preference for those which had received no Paris green.

All of the plants dried up somewhat sooner than they should have done. They did not, however, die from any disease, but from lack of proper cultivation.

Results.—The results of the experiment are tabulated on the preceding page.

The seven kinds of treatment arranged in the order of their value would, therefore, stand as follows:

(1) Bordeaux mixture (1-to-11 formula) and Paris green, five times.

(2) Bordeaux mixture (1-to-7 formula) and Paris green, five times.

(3) Bordeaux mixture (1-to-7 formula) and Paris green, four times.

(4) Bordeaux mixture (1-to-7 formula) alone, five times.

(5) Paris green in lime water, once; "Lion Brand" Bordeaux mixture and Paris green, four times.

(6) Paris green in lime water, five times.

(7) Fungiroid and Paris green dry, five times.

Comments on the results.—We can see no reason why 1-to-11 Bordeaux should give better results than 1-to-7 Bordeaux. It was expected that the position of these two treatments would be reversed. It should be borne in mind, however, that the fight was chiefly against insects and, consequently, the value of the Bordeaux mixture lay, for the most part, in its adhesive prop-

erty which caused it to hold the Paris green on the leaves. The 1-to-11 Bordeaux adheres just as well, but no better, than 1-to-7 Bordeaux. The difference (2.25 bushels per acre) is so slight as to make them practically equal. Had late blight been prevalent the results might have been different. In a season when potatoes blighted badly, Prof. L. R. Jones* of the Vermont Station found strong Bordeaux decidedly preferable to weak Bordeaux, but he did not use the same formulæ used in this experiment.

It was found wholly impracticable to get along with three applications of Bordeaux mixture. If any one of the first three treatments had been postponed the plants would certainly have been seriously injured by Colorado potato-beetles. And it would not have been prudent to omit the fourth treatment which was made July 24, because the plants would then have been unprotected against late blight which was liable to appear any time after July 15.

With Paris green, 1-to-7 Bordeaux mixture produced 19½ bushels per acre more than the same mixture *without* Paris green. This shows that Bordeaux mixture falls far short of furnishing complete protection against insects. Paris green must be used with it. It is to be noted, however, that Bordeaux mixture alone gave better results than Paris green (in lime water, Fungiroid and Paris green applied dry, or the "Lion Brand" Bordeaux mixture and Paris green; and this, too, when insects were the chief enemies. Bordeaux mixture certainly has considerable value as a repellent of insects.

The "Lion Brand" Bordeaux mixture with Paris green was a failure, giving but 3½ bushels per acre more than Paris green in water. The experiment does not prove that it may not have some value as a fungicide, because very little fungus was encountered in the experiment; but the experiment *does* prove that as a spraying mixture for potatoes it is decidedly inferior to ordinary Bordeaux mixture. It lacks the adhesive property of Bordeaux mixture.

Fungiroid with Paris green made an even worse showing. The rows treated with Fungiroid and Paris green yielded 6.25 bushels

*Vt. Agrl. Exp. Sta. Ninth Ann. Report, 1895, p. 97.

per acre less than the rows treated with Paris green in lime water. There being but little fungus, this difference represents the difference between applying Paris green dry and applying it in lime water. The Fungiroid and Paris green were applied according to directions on the can, namely, at the rate of two pounds per acre, applied on dry foliage with a Leggett powder-gun, and when there was but little wind. Although this experiment furnishes no information as to the fungicidal value of Fungiroid we do not hesitate to state that, in our opinion, the value of Fungiroid is so small as compared with liquid Bordeaux mixture that it has no claim to consideration from potato growers. Our opinion is based: (1) On the fact that Fungiroid lacks the adhesive property of Bordeaux mixture; (2) on the results of experiments at other experiment stations in which the merits of Fungiroid and Bordeaux mixture have been compared; (3) on the opinions of eminent authorities on plant diseases. Prof. L. R. Jones, botanist of the Vermont Experiment Station, experimented with Fungiroid and other forms of dry Bordeaux mixture on potatoes for two seasons. From the results of these experiments he draws the following conclusion:* "When these powders were applied dry, even in the most liberal amounts, they gave so little protection that their substitution for the ordinary or wet mixture is not to be recommended under any circumstances." In an experiment made by Mr. H. P. Gould† at the Maine Experiment Station, Fungiroid applied to potatoes increased the yield 10 per cent, while wet Bordeaux mixture increased the yield 31 2-3 per cent under parallel conditions. Prof. Galloway,‡ Chief of the Division of Vegetable Physiology and Pathology, United States Department of Agriculture, considers powder fungicides as a class much inferior to liquid fungicides.

The small yield on all parts of the experiment field was due to poor cultivation. The experiment furnishes a striking example of the fact that spraying cannot be made to take the place of cultivation.

* Loc. cit., p. 98.
† Me. Agrl. Exp. Sta. Bul. No. 28.
‡ *Rural New Yorker*, Vol. LV, Aug. 8, 1896, p. 528.

ONE HUNDRED GALLONS OF BORDEAUX MIXTURE PER ACRE VS. FIFTY GALLONS PER ACRE.

The following experiment was conducted on the farm of Mr. H. L. Hallock, near Jamesport, N. Y.:

Seven rows, 636 feet in length, were planted with potatoes of the variety White Elephant. Considerable care was taken to apply the fertilizer uniformly over the seven rows and to cut the seed potatoes in such a way as to leave two eyes to each piece. They were planted with a potato-planter. This was on land which had grown corn the previous season.

During the season they were sprayed five times with Bordeaux mixture, Paris green being added in the first two sprayings. The dates of spraying were June 9, June 22, July 8, July 22 and August 6. The Bordeaux mixture was applied with a Hudson Special Bordeaux Sprayer, a cut of which may be seen in Fig. 11. This sprayer is arranged to spray four rows at a time with two nozzles to each row, so that in going across the field and back again eight rows are sprayed. But instead of spraying eight rows we sprayed only seven and were thus enabled to double spray the center row; in other words, the center row received at each spraying exactly twice as much Bordeaux mixture as each of the other six rows. Since the sprayer applies Bordeaux mixture at the rate of about 50 gallons per acre, the six single sprayed rows received Bordeaux mixture at the rate of 50 gallons per acre and the double sprayed row or center row at the rate of 100 gallons per acre.

At digging time the tubers on the center row were weighed by themselves. The tubers on the other six rows were also weighed.

The double sprayed row yielded 430½ lbs. mechantable tubers, 35 lbs. culls.

The six single-sprayed rows averaged 390½ lbs. merchantable tubers, 52⅔ lbs. culls per row.

Difference in yield of merchantable tubers, 40 lbs. per row or 15 bu. 13 lbs. per acre.

The experiment was repeated on seven other rows of potatoes 536 feet long, planted on clover sod. The treatment was the same and the result was as follows:

The double-sprayed row yielded $463\frac{3}{4}$ lbs. merchantable tubers, 22 lbs. culls.

The six single-sprayed rows averaged $403\frac{11}{12}$ lbs. merchantable tubers, 21 lbs. culls per row.

Difference in yield of merchantable tubers, $59\frac{5}{6}$ lbs. per row or 27 bu. per acre.

To recapitulate, potatoes sprayed five times with Bordeaux mixture at the rate of 100 gallons per acre outyielded potatoes sprayed at the rate of 50 gallons per acre. The amount of the difference was in one case 15 bu. 13 lbs. of merchantable tubers per acre, and in another case, 27 bu. of merchantable tubers per acre.

As in the experiments at East Williston, the fight here was chiefly against flea-beetles and Colorado potato-beetles. There was very little disease of any kind to contend with.

The result of this experiment confirms us in a previously formed opinion based upon general observation, namely, that heavy applications of Bordeaux mixture give much better results than light applications, and that it will pay to use at least three nozzles per row in the last two sprayings.

A TEST OF THE HUDSON SPECIAL BORDEAUX SPRAYER.

Quite recently Long Island potato growers have begun to take considerable interest in the spraying of potatoes, and one of the greatest obstacles to progress in the practice of spraying is the difficulty of obtaining suitable machinery for applying the Bordeaux mixture. For gardens and small fields of from one to two acres the knapsack sprayer answers very well; but for the large fields of those farmers who make potatoes their chief farm crop, the knapsack is too tedious. In our opinion the most economical method of spraying these large fields is by means of a home-made outfit similar to the one shown in Plate XIV. There are, however, many farmers who object to the labor required to operate such an

outfit. They desire a sprayer so arranged that all of the work is done by horse power. Sprayers of this description are necessarily somewhat complex and consequently expensive. Several different kinds have been placed upon the market, but they have been so defective in various ways that farmers have become suspicious of this class of sprayers. The perfect power sprayer for potatoes has not yet appeared.

In the spring of 1896, the Riverhead Agricultural Works, Riverhead, N. Y., put out a new Hudson Special Bordeaux Sprayer. This machine having certain new, and, apparently, desirable features, and being manufactured and sold by a firm located in the potato growing section of Long Island, it seemed necessary for us to test it so that we might be able to answer correctly the inquiries which are certain to arise concerning it.

We used it throughout the season of 1896 for spraying about seven acres of potatoes near Jamesport, Long Island, and found it quite satisfactory. One of the strong points of the sprayer is the manner in which the nozzles are arranged. There are two nozzles to each row, and they can be readily adjusted to suit the size of the plants. We are thoroughly convinced that one nozzle per row is entirely insufficient, except, perhaps, for the first spraying.

We experienced very little difficulty from clogging of the nozzles. The Bordeaux mixture is drawn from the bottom of the barrel and this is generally considered an objectionable feature, since there is more liability of the nozzles clogging than there is when the escape tube leaves the barrel from the top. But in the Hudson sprayer the agitation of the liquid is so thorough that this difficulty is overcome, provided a reasonable amount of care is used in straining the Bordeaux mixture and in rinsing out the barrel. The ease with which the barrel can be filled is another good feature of the machine.

This sprayer should give excellent satisfaction, if in operating it the following rules are heeded:

(1) *The Bordeaux mixture must be thoroughly strained.*— The strainer furnished with the sprayer is entirely sufficient. Everything that goes into the barrel should be passed through this

strainer. There need be no difficulty in getting Bordeaux mixture through the strainer if the Bordeaux is properly made. First of all, see that the barrel in which the Bordeaux is to be mixed is free from sticks and dirt — rinse it well. Always strain the lime water and if there is dirt in the water, strain it also. With proper management this straining process need not consume much time and in the end there will be a great saving of time. Avoid a great excess of lime in the Bordeaux.

(2) *At the close of each day's work pass a small quantity of clean water through the nozzles and rinse the barrel.*—This should always be done but is most important when Paris green is used with the Bordeaux mixture.

DIRECTIONS FOR SPRAYING POTATOES ON LONG ISLAND.

Spray every season. Begin when the plants are from six to eight inches high and spray once every two weeks as long as the plants continue green. If heavy rains occur it may be necessary to spray somewhat oftener, particularly in seasons when late blight is prevalent. Use Bordeaux mixture of the 1-to-8 formula; that is, use one pound of copper sulphate for every eight gallons of Bordeaux mixture. When Colorado potato-beetles or flea-beetles are abundant add Paris green to the Bordeaux mixture at the rate of three-fourths of a pound of Paris green to 50 gallons of Bordeaux mixture. Spray thoroughly. If a sprayer with stationary nozzles is used there should be two nozzles per row in the first three spraying and three nozzles per row in all subsequent sprayings. It is, however, sometimes difficult to arrange the nozzles so that three per row can be used with advantage. In such cases it may be advisable to use, instead, two nozzles per row and go over the plants twice in opposite directions. By all means, spray thoroughly in the latter part of the season.

This treatment can be depended upon to prevent early blight and late blight or rot, keep off Colorado potato-beetles and considerably reduce the amount of damage done by flea-beetles.

Plate XV.—Young Sweet Corn Plant Affected with Bacterial Disease. About Three-fourths Natural Size.

III. A BACTERIAL DISEASE OF SWEET CORN.*

F. C. STEWART.

SUMMARY.

In the market gardens of Long Island, early varieties of sweet corn are much subject to a wilt disease in which the fibro-vascular bundles of the plant are gorged with multitudes of short, yellow bacilli. The disease is certainly different from Burrill's corn disease and is one which has not heretofore been reported. The yellow bacillus found in the fibro-vascular bundles is undoubtedly the cause of the disease and brings about the death of the plant by cutting off the supply of water. It has been artificially cultivated on various culture media and its behavior recorded. The disease seems to be confined to sweet corn and is most destructive to early varieties. Field corn and pop corn are entirely exempt. Outside of Long Island it is positively known to occur only in Iowa, but, probably, careful search will show that it is widely spread. It is disseminated chiefly by means of the germs which cling to the seed, but also by manure, implements and washing of the soil. As for remedial measures, the principal things to be observed are: (1) Care in the selection of seed and (2) the planting of resistant varieties. Lime and sulphur, applied to the soil have been tried and proven unsuccessful.

INTRODUCTION.

During the past three years the writer has had under observation a bacterial wilt disease which has done considerable damage to sweet corn in the market-gardens of Long Island. The disease was originally discovered at Queens, N. Y., on a very early, dwarf variety of sweet corn named Manhattan. It has since been found affecting many different varieties and in all parts of Long

*Reprint of Bulletin No. 130.

Island. Certain varieties have been much more severely attacked than have others, but the disease has been widespread on Long Island and, in several instances, destructive, particularly in the season of 1897. Occasionally, an entire crop has been ruined and losses of from 20 to 40 per cent have been frequent; but in the majority of cases the loss has been so slight as to pass unnoticed by the farmer, although one familiar with the disease could readily detect it in almost any field of early sweet corn on Long Island during the past season.

Although we had here to deal with a disease of considerable economic importance, it soon became evident that it is an undescribed disease caused by a species of bacterium which is probably unknown to science. Previous to the discovery of this disease, the only known bacterial disease of corn (*Zea mays*) was one described by Burrill* in 1889. Burrill's disease affects field corn and differs so widely from the disease under consideration that there is no doubt that the two are entirely distinct.

SYMPTOMS OF THE DISEASE.

Some bacterial diseases of plants are very difficult to diagnose. They have no characters by which they can be readily identified without the aid of a compound microscope, and for some diseases the revelations of the microscope must be supplemented by information obtained from the study of cultures. Fortunately, this disease of sweet corn has some distinguishing characters by which it can be identified with certainty and without the aid of a microscope.

The affected plants wilt and dry up without any apparent cause. This may occur at any stage of growth but it is most likely to occur about the time of flowering. The past season it was observed to be very prevalent as early as June 12, among plants which were from eight to ten inches in height. The leaves wilt and then gradually wither. The time which elapses between the first appearance of the disease and the death of the plant varies greatly. In some cases it may be no more than four days, while in others it may occupy a month. Sometimes an affected

*Burrill, T. J. A Bacterial Disease of Corn. Ill. Agl. Exp. Sta. Bul. No. 6.

plant will completely recover, or it may recover for a time and succumb to the disease later. Occasionally, all of the leaves of a plant will wilt simultaneously (this is most likely to happen with small plants), but more often they die one after another so that wholly dry leaves and green leaves may be seen on the same plant. There is no abnormal coloration — it is simply a drying up of the tissues. There is nothing abnormal about the roots and the subterranean portion of the stem appears sound and normal except in the case of plants which have been dead for some time. Such plants may show black decay spots on the subterranean stem; but decay does not set in until the whole plant is dead and even then progresses slowly. The fact that the whole interior of the lower end of the stem is brown signifies nothing. This browning is found in healthy plants as well as in the diseased ones.

The most distinctive character of the disease is revealed when the stem is cut lengthwise. The fibro-vascular bundles appear as yellow streaks in the white parenchyma; but in the stems of plants which have been dead for some time some of the bundles may be black instead of yellow. If the stem is cut crosswise and the cut surface exposed to the air for about five minutes, a yellow, viscid substance exudes in drops from the ends of the vessels. This yellow substance in the fibro-vascular bundles is composed of bacteria. It is an invariable accompaniment of the disease and in plants which have died from the disease it will be sufficiently abundant to be seen easily with the naked eye. Thus we have in this yellow substance a character by which the disease may be readily identified. It should be stated, however, that in very young plants the yellow substance is detected less easily than in large ones with well-developed vascular systems; and, also, that the microscope will show its presence in the vessels of the plants before it can be detected with the naked eye and before there is any outward manifestation of the disease except in the dwarfed condition of the plants.

Fields of sweet corn affected with the disease are very uneven, particularly at the time when the ears are forming. Plants in

various stages of the disease are intermingled with apparently healthy plants of different sizes. It is a common thing to find diseased plants in the same hill with healthy ones which may continue in good health to the end of the season. There are no indications that the disease is communicated from one plant to another. It does not spread from an initial center, but is scattered all through the field. Usually, the small plants are the first to succumb to the disease, which fact suggests that the disease may be the cause of their slow growth. This suspicion was confirmed by microscopic examination. Plants green and apparently healthy, except for their small size, were found to contain a considerable quantity of the bacterium in their vessels, while in the larger, more vigorous plants the bacterium could not be found. However, in wet weather the bacterium may sometimes be found in quite vigorous plants. This feature of the disease will be discussed more fully on a subsequent page.

The bacterium invades the vessels of all parts of the plant, including the roots. Plants which did not succumb to the disease until after the ears had commenced to form were examined after they were dead but before they were completely dry, and the bacterium was found in abundance in the vessels of all parts of the stem clear up to the tassel and in the ear, where it oozed out onto the kernels and the inner husks. The ears showed no tendency to rot.

BACTERIA THE CAUSE OF THE DISEASE.

Since affected plants behave very much like plants suffering from lack of moisture, except that there is little or no "rolling" of the leaves, careless observers are liable to think that dry weather is the cause of the trouble. This theory is at once rendered untenable by the fact that plants die from the disease in wet weather as well as in dry weather. Some have attributed the trouble to the fertilizer used, but one does not have far to seek to remove suspicion from the fertilizer. It is also easily demonstrated that insects are not responsible for it. Various species of fungi may be found on the roots of dead plants but no

species is constantly associated with the disease and fungous hyphæ are to be found on the interior of the stem only in decayed specimens. A pink Fusarium grows in great profusion on the sheathing bases of the leaves and *Epicoccum neglectum* Desm. is common on the dead leaves, but both of these fungi are saprophytes and do not appear until the leaves are dead.

The yellow mass of bacteria in the vascular system becomes an object of suspicion as soon as it is observed. These bacteria make their appearance before the plant commences to wilt and by the time the plant is wholly dead the vessels are gorged with them. If the bacteria have nothing to do with the disease how can their presence be explained? Russell* has shown that "normally, the healthy plant, with intact outer membranes, is free from bacteria within its tissues." Concerning the possibility of saprophytic bacteria gaining access to healthy plant tissue through the medium of wounds, the same author reports experiments† in which it was shown that, although certain saprohytic species are capable of spreading through healthy tissue, they do not penetrate to any great distance nor multiply rapidly. Therefore, on account of the immense numbers of the corn bacterium which may be found throughout the vascular system of every affected plant, even in the early stages of the disease, and its scarcity in the tissues of vigorous, healthy plants, coupled with the fact of the absence of any other sufficient cause, it is safe to assume that the yellow bacterium is the cause of the trouble. Conclusive proof of this, however, is to be obtained only from inoculation experiments.

ISOLATION OF THE GERM.

Pure cultures of the germ are easily obtained. It grows readily, at a temperature of from 21° to 28°C., on neutral beef agar, neutral potato agar or neutral gelatin. By carefully splitting open the stem of a freshly wilted plant and touching a sterilized platinum needle to one of the bacteria-laden vessels it is quite

*Russell, H. L. Bacteria in Their Relation to Vegetable Tissue. A dissertation presented to the Board of University Studies of the Johns Hopkins University for the degree of Doctor of Philosophy. Friedenwald Company, Baltimore, 1892, pp. 3-6.

†Non-Parasitic Bacteria in Vegetable Tissue. Bot. Gazette, Vol. XVIII, pp. 93-96.

easy to obtain a Petri-dish culture which is almost entirely free from foreign germs. This can be done with small plants but it is more easily accomplished if the plants are large and have well-developed stems. Unless there is an undue amount of moisture on the surface of the medium the colonies show no tendency to spread and run together.

INOCULATION EXPERIMENTS.

Attempts to inoculate field-grown plants of sweet corn have been unsatisfactory because it has been practicably impossible to obtain plants which were known to be free from the disease. Susceptible varieties have been quite generally affected, and since the disease is one which acts slowly it is not possible to get results of much value from inoculation experiments made upon plants among which the disease previously existed, even to a slight extent. Only one of the field experiments is worth reporting in detail. It is as follows: In 1896 thirteen hills of Manhattan sweet corn were planted in one row. In each of the first seven hills there was placed, at time of planting, a handful of dirt taken from soil in which the disease was prevalent the preceding season. The remaining six hills were left untreated for comparison. When the plants were a few inches high they were thinned to four in a hill. A few of the plants in the inoculated hills began to wither before they were a foot high and from this time on they withered one by one, until on July 20th, when the kernels were "in the milk," all of the inoculated plants except two were either dead or dying. At this date, not a single plant in any of the uninoculated hills showed any symptoms of the disease; but later in the season several of the plants became affected. How they came to be affected is not known. While this experiment was not wholly satisfactory the results tend to show that the disease is communicable.

Several attempts were made to inoculate sweet corn by puncturing the stem near the ground and inserting a small quantity of the diseased tissue of an affected plant. In some of the large varieties the inoculated plants remained healthy to the end of

the season. In the smaller varieties the disease usually appeared in from two to four weeks after inoculation, but the uninoculated plants used as a check, likewise, invariably became affected to a considerable extent so that no trustworty information could be obtained from such experiments.

Finally it became evident that the plants must be grown in pots of sterilized soil if the inoculation experiments were to furnish results of any value. A quantity of soil was thoroughly sterilized in steam sterilizers and placed in large pots. On July 3 Early Cory sweet corn (grown in Iowa) was planted in the pots and inoculation experiments with pure cultures of the yellow germ were started. The pots were allowed to remain uncovered; otherwise, all precautions were taken to prevent contamination. Nevertheless, an undoubted case of the disease was found in one of the check pots on August 3d, and later several others were found. This meant that diseased seed had been used and the experiment was worthless except to prove that infection may be brought about by the germs which cling to the seed.

Three unsuccessful attempts were made to produce the disease in yellow dent field-corn by inoculation. On August 20th, 1895, ten plants of yellow dent corn (variety unknown) were inoculated by puncturing the stem at the surface of the soil with a sterilized scalpel and then inserting into the puncture a small quantity of the yellow substance taken directly from the interior of the stem of a diseased sweet corn plant. These plants were under observation until frost (about October 7th) but none of them showed any symptoms of the disease. On July 12, 1897, twenty plants of yellow dent corn, variety Golden Dent, were inoculated in the same manner as in the experiment of 1895. None of these plants developed outward symptoms of the disease, but a month after inoculation it was found that in several of the plants the yellow bacillus had ascended a few of the fibro-vascular bundles where it was visible to the naked eye as far as the third node above the point of inoculation. It was noticeable, however, that it occurred only in bundles which had been ruptured by the needle used in inoculation. In 1897 a 50-foot row of the same Golden Dent corn

was inoculated by placing in the drill, at the time of planting, a liberal quantity of soil in which diseased plants had grown the preceding season. Not a single plant developed the disease.

Pop corn, also, has resisted all attempts at inoculation. In 1897 a 50-foot row of pop corn, variety Maple Dale, was inoculated by putting diseased soil in the drill at time of planting. None of the plants became diseased. On July 8, 1897, twenty plants of the same variety of pop corn were inoculated by puncturing the stem and inserting diseased tissue into the wound as in the experiments with sweet corn and field corn. None of the plants became diseased, but as in the case of field corn the germ could be seen in some of the bundles up to the third node.

Oats inoculated by means of diseased soil, and teosinte (*Euchlœna luxurians*), inoculated both by puncture and diseased soil gave negative results.

DESCRIPTION OF THE GERM.

Morphology.—A short bacillus with rounded ends; usually occurring in pairs with a plain constriction between the members. A pair varies in length from 2.5 microns to 3.3 microns, and in width or diameter from .65 micron to .85 micron. (See Plate XVI, fig. 1.) No spores have been observed, but since an extended examination of old cultures has not been made it can not be stated with certainty that spores are not formed. The organism is plainly motile but not actively so.

Growth on agar.—The organism grows readily on neutral agar of the following composition: Finely chopped beef, 500 grams; Witte's peptonum siccum, 5 grams; agar, 15 grams; water, 1 liter; made neutral with sodium carbonate. In Petri-dish cultures on this medium the colonies become plainly visible within forty-eight hours at a temperature of 22° to 25° C. The buried colonies soon become spindle-shaped, while the surface colonies are circular and with nearly smooth outline. From the very start the colonies have a light yellow color which deepens to light orange-yellow in the course of about a week. The surface colonies are smooth and shining and show no tendency to spread

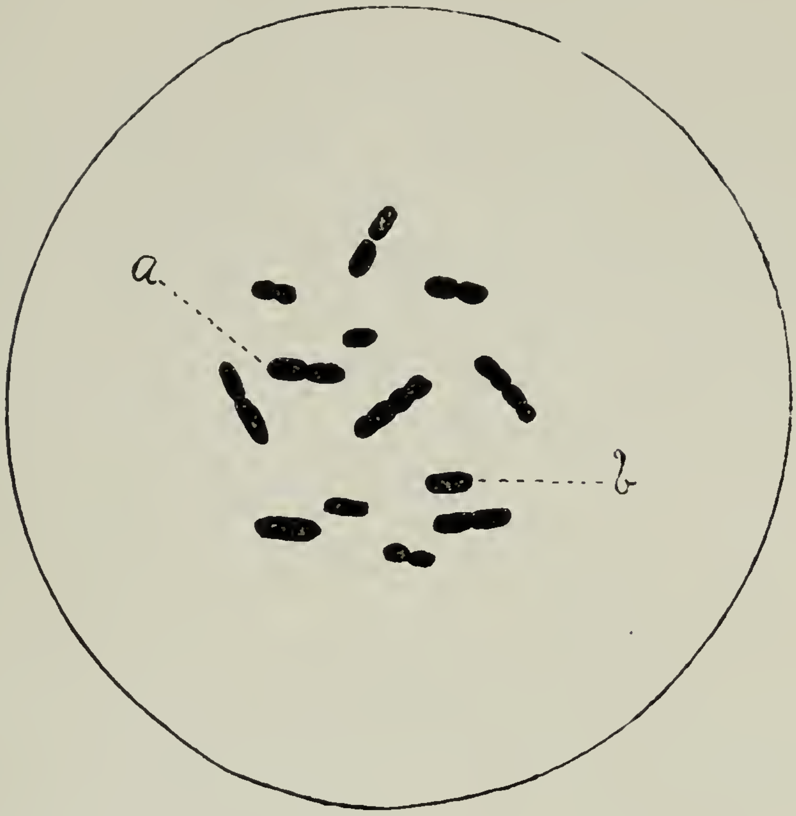


PLATE XVI. FIG. 1.—VARIOUS FORMS OF THE SWEET CORN BACILLUS GROWN ON POTATO AGAR; *a* AND *b* ARE TYPICAL FORMS. MAGNIFICATION, 1,875 DIAMETERS.

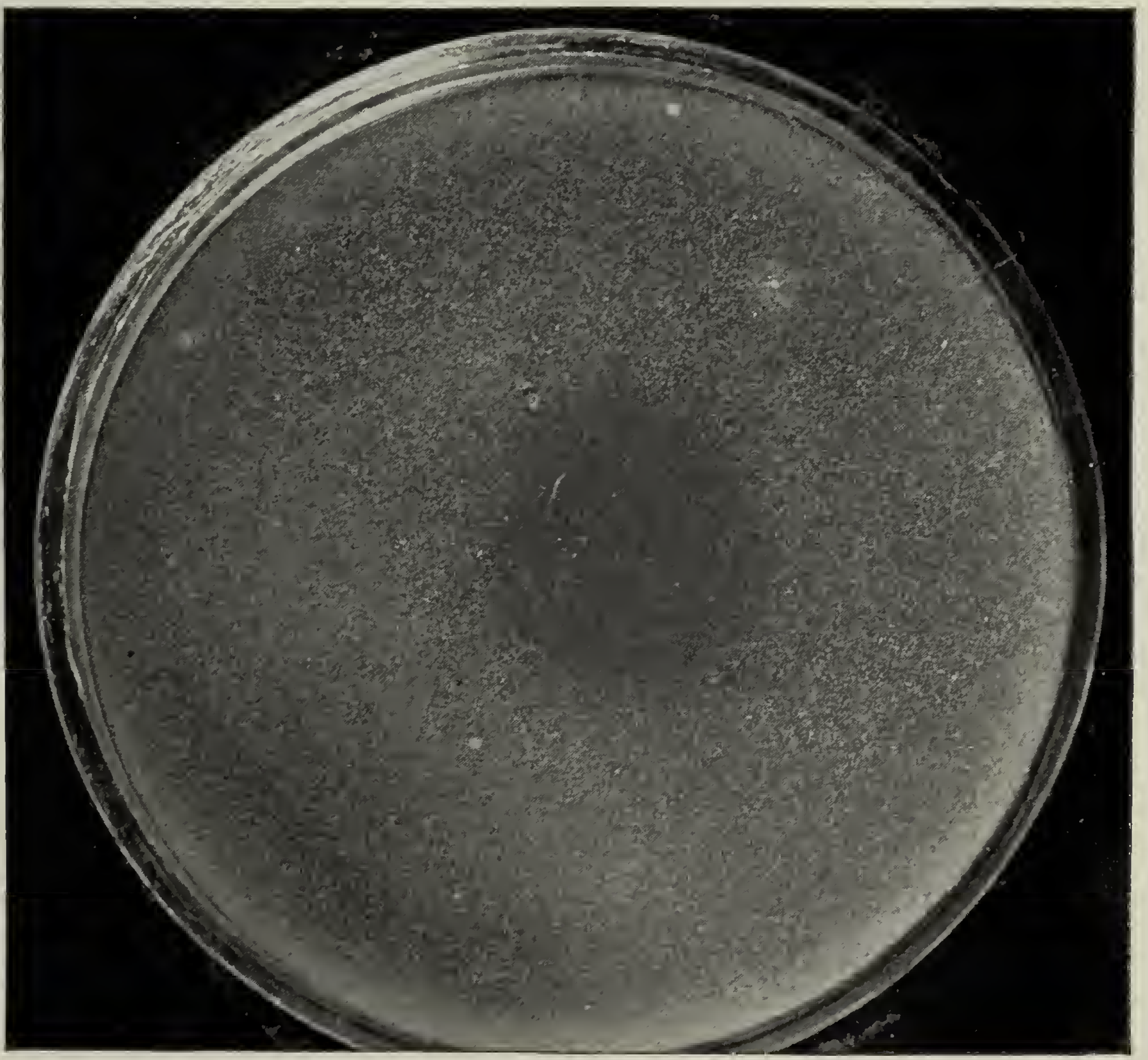


PLATE XVI. FIG. 2.—PETRI-DISH CULTURE OF THE SWEET CORN BACILLUS SHOWING EFFECT OF EXPOSURE TO SUNLIGHT.

widely over the surface of the agar. In streak cultures there is considerable growth at the end of twenty-four hours at the room temperature. This growth is at first dirty yellowish-white, but gradually changes to a deep yellow (a color expert pronounced it "raw sienna"). The margins of the growth are quite strongly lobulated, but well defined. The surface is at first smooth and shining, but as the water evaporates from the agar granulation takes place, commencing in the upper part of the tube. It does not grow down into the agar nor color the agar. No odor is produced. In stab cultures there is considerable growth along the needle-track. The "nail-head" growth is thick, its margin is slightly irregular and of a deeper yellow than the interior. For a considerable length of time the surface is smooth but eventually it becomes granular as in streak cultures.

The organism grows readily, also, on potato agar which is prepared by adding ten grams of agar to one liter of potato broth. The color and habit of growth are practically the same as on beef agar.

Growth on gelatin.—The gelatin used was the following comcomposition: Beef, 500 grams; Witte's peptonum siccum, 10 grams; gelatin (Compte Fils à Madgebourg, first quality), 150 grams; water, 1 liter; neutralized with sodium carbonate. On this medium, at the same temperature, the organism grows less rapidly than on agar. In streak cultures the growth is narrow, quite thick, smooth and shining on the surface and smooth along the margins. The color is a trifle lighter than on agar, and there is no granulation until the seventh or eighth week. There is no growth down into the agar. In stab culture the "nail-head" growth is of small diameter, thick, smooth and shining, smooth around the margin and of orange-yellow color. Along the needle-track there is considerable of a dirty yellowish-white growth. The needle-track does not become funnel-shaped. There is no liquefaction of the gelatin.

Growth on potato.—On sterilized slanted potato cylinders the organism grows very rapidly. Potato seems to be its favorite culture medium. At a temperature of 26°C. there is a copious

growth in twenty-four hours. It spreads irregularly over the slanted surface, is smooth, and for three or four days has the same color as on agar, but at the end of a week it is slightly iridescent. In 48 hours the potato cylinder begins to turn brown and in a week it is decidedly brown. A yellowish-white precipitate forms in the water at the bottom of the tube. No gas bubbles are formed.

Growth in bouillon.—It grows in bouillon, either neutral or made quite strongly acid with malic acid, but the growth is not conspicuous. In bouillon containing 500 grams beef and ten grams Witte's peptonum siccum per liter it produces, in twenty-four hours, a slight cloudiness which increases very slowly. At the end of three weeks some flocculent white precipitate is formed, the liquid is moderately cloudy, and, if the tube has remained quiet for several days, the surface will be covered by a thin film bearing raised, yellow colonies of the size of a pin-head.

Growth in peptone solution.—The peptone solution of Dunham was used. The formula is as follows: Distilled water, 1 liter; peptone (Witte's peptonum siccum in the present case), ten grams; sodium chloride, 5 grams. In twenty-four hours there is a slight turbidity which becomes quite pronounced at the end of a week. There is a small quantity of dirty-white precipitate in the bottom of the tube, but no membrane forms on the surface. With age, the precipitate becomes light yellow in color.

Growth in milk.—Sterilized skimmed milk is changed very slowly by the germ. By the fourth week there is usually a thin layer (5 to 8 millimeters thick) of clear liquid in the upper part of the tube, while the remainder appears unaltered.

Chemical reactions produced by its growth.—The pale rose color of peptone-rosolic-acid solution is slightly intensified, indicating the presence of a small amount of some alkali, but if this is the case the quantity produced is not sufficient to overcome the slight acidity of the water in the bottoms of tubes containing sterilized potato cylinders. And the behavior of tubes of litmus milk inoculated with the germ indicate the production of acid rather than alkali. During the first three weeks the color of

litmus milk becomes just a shade lighter blue, but during the following three weeks the blue color entirely disappears, leaving the milk very nearly the color of normal milk and with no precipitation of the casein. The cause of this peculiar behavior of litmus milk is not known to the writer.

Peptone-rosolic-acid solution is prepared by adding to 100 cubic centimeters of Dunham's peptone solution (see formula previously given), 4 cubic centimeters of the following solution: Rosolic acid, 0.5 grams; alcohol (80 per cent), 100 cubic centimeters.

The litmus milk was prepared as follows: One cubic centimeter of a saturated aqueous solution of Trommsdorf's litmus was put into a test-tube containing ten cubic centimeters of sweet skimmed milk and the whole sterilized. After sterilization the contents of the tube were of a pale blue color. It was tested with malic acid and potassium hydrate and found to react properly.

Growth on acid and alkaline media.—The organism appears to grow best on neutral or slightly acid media. A comparatively slight degree of alkalinity is sufficient to prevent growth wholly, but on the acid side there is a wider range. It grew very feebly on 10 c. c. of agar containing 0.05 c. c. of a saturated solution of sodium carbonate. However, on agar containing 0.02 c. c. of a saturated solution of sodium carbonate per 10 c. c. of agar it grew readily and with the same color and habit of growth as on neutral agar. In sterilization, the agar containing the larger amount of sodium carbonate browned slightly. The tests with acid media were made in bouillon acidified with malic acid. The germ grew readily in bouillon containing as much as 1 c. c of a 1 per cent solution of malic acid per 10 c. c. of neutral bouillon. When double this amount of malic acid was used no growth was obtained.

Gas production.—The organism does not produce gas by the fermentation of grape sugar, cane sugar or milk sugar. Tubes of neutral agar containing two per cent of these sugars were inoculated, thoroughly shaken and cooled quickly. Numerous small colonies of the germ developed throughout the medium but

in no case were any gas bubbles formed. In fermentation tubes containing two per cent of the above sugars in bouillon there was an abundant growth but no gas was formed.

Need of oxygen.—The organism is a facultative anaerobe, growing almost, if not quite, as readily in air which has been robbed of its oxygen by Buchner's pyrogallic acid method as it does in normal air. The color, however, is a lighter shade of yellow.

Temperature relations.—Under this head it can only be said that it grows vigorously at all temperatures between 21° and 30° C. The thermal death-point has not been determined.

Behavior toward stains.—It takes the basic aniline stains readily, staining uniformly throughout.

Relation to light.—It is not injuriously affected by diffused light but exposure for a few hours to direct sunlight kills it. Over the cover of an ordinary Petri-dish containing a culture of the organism on potato agar, there was pasted a piece of black cloth which had at the center a circular hole of 1.8 cm. in diameter. The Petri-dish was then placed in bright sunlight for three hours, after which it was incubated for 96 hours at a temperature of about 23° C. The yellow bacterial colonies came up thickly all over the agar except at the center, directly underneath the hole in the black cloth. Here there were just a few colonies, most of the germs* on this area having been killed by exposure to the sun.

Plate XVI, fig. 2, is from a natural-size photograph of the culture with the cover removed. It will be seen that the circular area over which the bacteria are killed has a diameter somewhat greater than that of the hole in the cloth. This is due to the fact that the rays of sunlight did not strike the cover at right angles.

PATHOLOGICAL HISTOLOGY.

As already stated, the organism occurs in the vascular system throughout the entire plant. It is never found in the parenchyma cells, but in the fibro-vascular bundles exclusively, and is there probably confined to the vessels. There is no disorganization or discoloration† of any of the tissues.

* Prof. H. Marshall Ward has published a very interesting paper entitled, Action of Light on Bacteria, III. Philosophical Trans. of the Soc. of London. Vol. 185, Part II, pp. 961-986. 1894. On page 964 he makes some suggestions as to why (in experiments like the above) the germs on the exposed area are not *all* killed.

† The blackening of the fibro-vascular bundles, a not uncommon occurrence, is not due to the action of the corn bacterium.

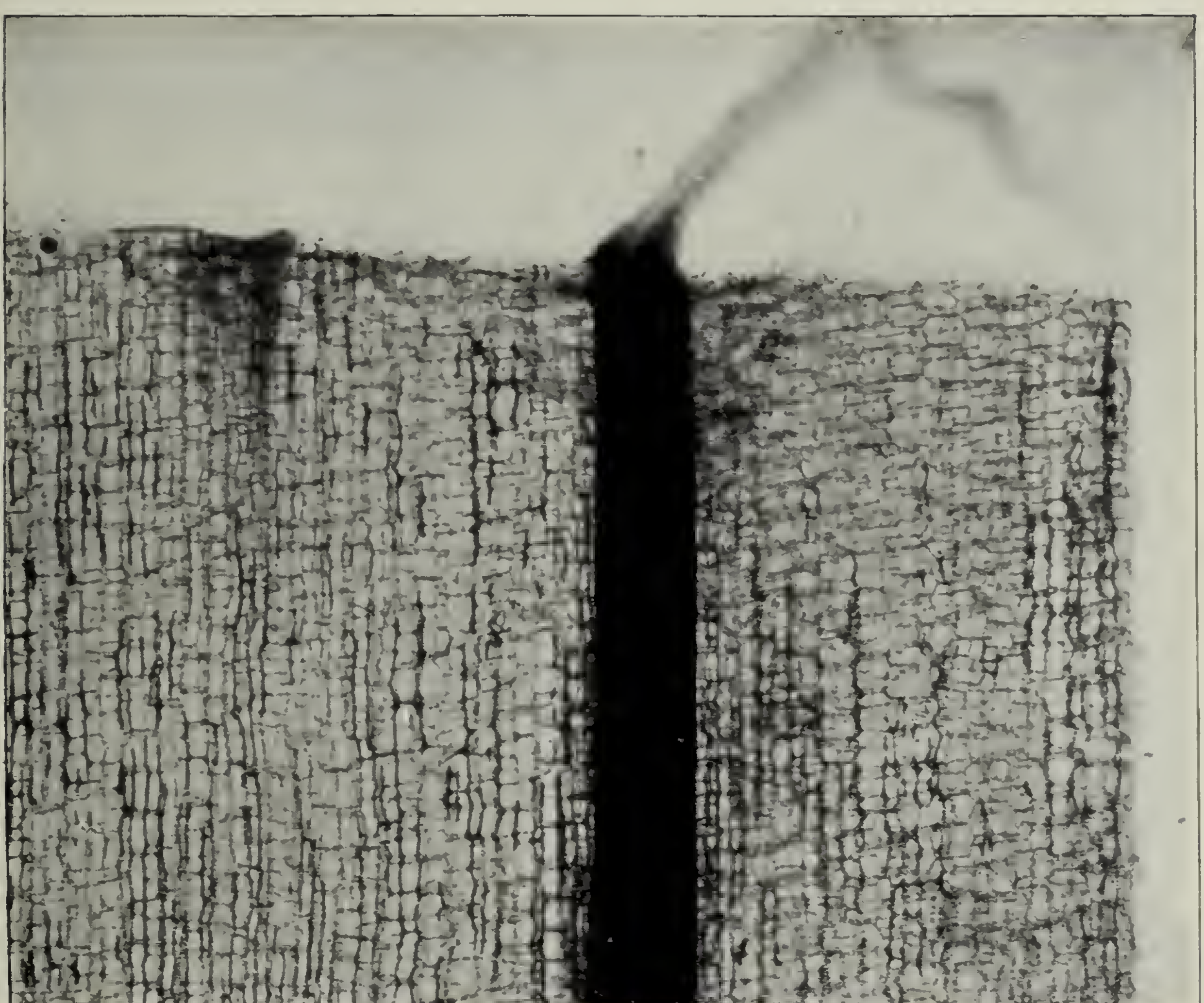


Plate XVII.—Photomicrograph of a Longitudinal Section of a Diseased Sweet Corn Stem Mounted in Water, Showing the Bacteria Swarming from the End of a Fibro-vascular Bundle.

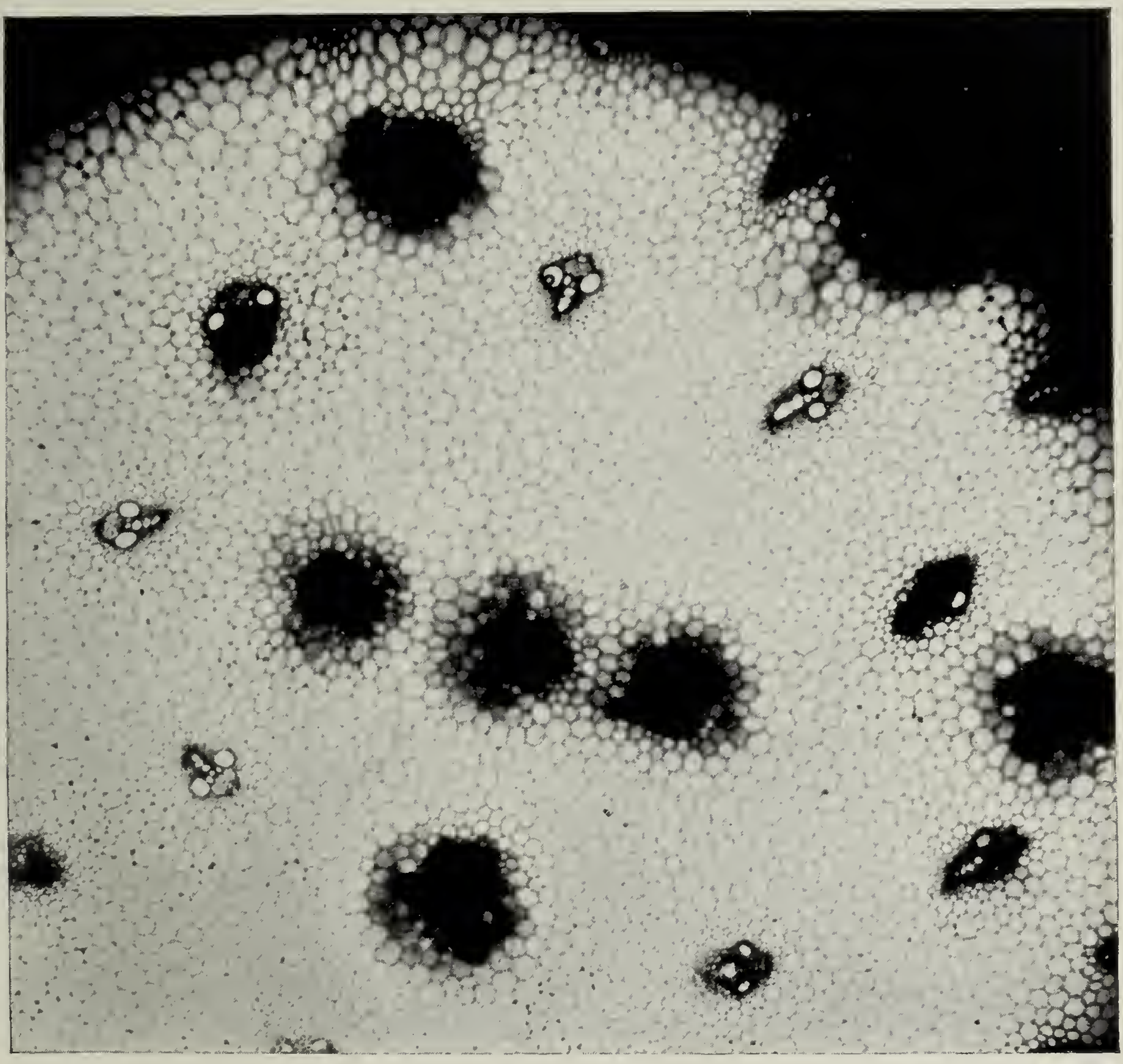


Plate XVIII.—Photomicrograph of a Cross-section of a Diseased Sweet Corn Stem Mounted in Water. The Structure of the Fibro-vascular Bundles in which the Bacteria Occur is Often Entirely Obscured by the Bacteria.

While it is undoubtedly true that the germ robs its host of a great deal of nourishment, the death of the host-plant seems to be due, chiefly, to the cutting off of the water supply. This view is supported by the fact that in dry weather plants growing in moist situations suffer less from the disease than plants growing in drier situations; and while plants may die from the disease in wet weather it is most virulent in dry weather. If plants are examined in periods of wet weather it will be found that the amount of the yellow substance which they may contain in their vessels without showing outward symptoms of the disease is much greater than it is in dry weather. Ordinarily, it is not easy to detect the germ in plants which show no outward symptoms, either by wilted leaves or dwarfed size; but in very wet weather plants seemingly in perfect health will be found to contain a considerable quantity of the germ. It is interesting to observe the effect of alternating periods of wet and dry weather. For about one month preceding July 12, 1897, it was very dry on Long Island — so dry that in the latter part of the period some crops suffered severely. During this time the corn disease was very destructive. Then came about three weeks of rainy weather followed by a short period of dry weather. Many plants which were partially dead revived during the rainy season and promised to outgrow the disease, but as soon as the rains ceased they suddenly collapsed.

The vessels, which constitute the chief avenue for the ascent of water, are so thoroughly plugged with millions upon millions of bacteria that it is indeed no wonder that the plant dies from lack of water. A good idea of the immense numbers of bacteria which throng the vessels may be obtained by examining Plate XVII, which is a photomicrograph of a longitudinal section of a diseased corn stem. The bacteria swarm out of the ends of the vessels like smoke out of a chimney. In cross-section (See Plate XVIII), they ooze out in such numbers as to obscure the structure of the fibro-vascular bundles.

The germ seems to have no power to pass through the walls of the parenchyma cells. This was especially noticeable in field corn and pop corn plants artificially inoculated by puncture. The germ was to be found only in the bundles which had been rup-

tured. It was unable to gain access to the vessels of unruptured bundles because of its inability to pass through the intervening parenchyma.

IDENTITY OF THE GERM.

It is by no means certain that this germ has not been previously described and named. Systematic bacteriology is, at present, in such a state of confusion that, even with access to all of the literature, one can scarcely avoid frequently falling into error. The writer, unfortunately, has had access to only a small part of the systematic literature and, therefore, it would be manifestly injudicious for him to give the organism a name which may, perhaps, only serve to burden the synonymy. Hereafter it will be referred to simply as the sweet corn bacillus. It is hoped that the foregoing description is sufficient for the complete identification of the organism, so that one having the necessary facilities may find no difficulty in referring it to its proper species if it has already been described.

While it is possible that the organism has been previously described, its habit of producing disease in sweet corn has surely not been reported heretofore. Burrill's corn germ, *Bacillus cloacæ** Jordan, the only other bacterium described as producing disease in *Zea mays*, is undoubtedly different. It attacks field corn while the sweet corn bacillus attacks only sweet corn; plants attacked by the sweet corn bacillus do not turn yellow and there is no moist rot of the ears; the sweet corn bacillus is conspicuous in the fibro-vascular bundles and exudes in yellow, viscid drops from the cut ends of stems, while neither is true of Burrill's germ; on agar, the sweet corn bacillus is yellow, while Burrill's germ on this medium is grayish. There are still other points of difference but those mentioned are sufficient to show that the two organisms belong to different species.

*It appears that Burrill never gave his corn germ a name and yet Ludwig (Lehrbuch der niederen Kryptogamen, p. 95) calls it *Bacillus secales* (Burrill), and Russell (Bacteria in their Relation to Vegetable Tissue, p. 36) uses the name *Bacillus zeæ* Burrill. The studies of Dr. Theobald Smith (The Wilder Quarter-Century Book, 1893, p. 214) and of Dr. V. A. Moore (Agricultural Science, VIII, pp. 368-385) have shown that it is identical with *Bacillus cloacæ* Jordan (Report Mass. State Board of Health; Water Supply and Sewerage, Part II, 1890, p. 836) which is probably the proper name to apply to it.

DISSEMINATION OF THE GERM.

The chief method of dissemination of the germ is, probably, by diseased seed. That seed from diseased plants may contain the germs, usually in great number, is certain, and we have proven by experiment that some, at least, of these germs retain their vitality long enough to infect the plants of the new crop. Plants of the variety Early Cory were grown in pots of sterilized earth which were watered, when the rain-fall was insufficient, with sterilized water. Every precaution, except that the pots were not covered, was taken to prevent contamination and yet several of the plants developed the disease. In this case, the infection must have been brought about by germs which clung to the seed. As an item of contradictory evidence, it should be mentioned that a pure culture of the germ on potato agar was found to be dead at the end of eleven months.

Another common way in which the germ is disseminated is in the use of stable manure made by animals which have been fed on the diseased corn stalks. It may also be disseminated by means of the implements used in cultivation and by the washing of the soil during heavy rains.

GEOGRAPHICAL DISTRIBUTION.

The disease occurs in abundance throughout Long Island. The only other locality in which it is positively known to occur is in Iowa, and the proof of its existence there is based upon the experiment above mentioned, in which Iowa-grown seed planted in pots of sterilized earth produced plants which developed the disease. A wilt disease of early sweet corn has been reported to us from Madison, N. J., but no specimens were sent. In view of the fact that the disease may be disseminated by means of the seed, it is impossible to believe that it is confined to Long Island. In all probability it is widespread.

REMEDIES.

Since the cause of the disease is entirely within the tissues and probably gains entrance through the subterranean parts of the plant, the application of fungicides to the parts above ground

must be absolutely without avail. In the application of fungicides to the soil there is a possibility of success but it can scarcely be said that this line of treatment is a promising one. Soil treatment for the fungous and bacterial diseases of plants has been successful in only a few instances. Lime is known to be a remedy for the club-foot disease of cabbage and the experiments of Thaxter* indicate that sulphur applied to the soil is a preventive of onion smut; but neither of these substances seems to have any beneficial effect on the sweet corn disease. Two rows of sweet corn (one row of Manhattan and one row of Early Cory) fifty feet in length were treated with air-slaked lime by scattering the lime, at the rate of 900 pounds per acre, in the drills with the seed. Two other rows of sweet corn (same varieties) were treated in the same manner with flowers of sulphur applied at the rate of 300 pounds per acre. Every plant in the four rows died from the disease, in most cases without forming ears. In the case of the lime it may be that better results would have been obtained if the lime had been applied to the soil several months before planting.†

The planting of non-susceptible varieties, as far as practicable, is, of course, to be recommended. There are marked differences of susceptibility among varieties, and this fact can often be turned to good advantage. In case it is necessary to plant susceptible varieties it may be found advantageous to soak the seed before planting in some germicide; for example, a weak solution of corrosive sublimate. However, treatment of the seeds with chemicals must be made with caution as there is danger of injuring the germination. The ears of diseased plants should never be used for seed.

---

*Thaxter, R. Conn. Agl. Exp. Sta. Ann. Rept., 1889, pp. 146-152.

†If air-slaked lime is applied the fall before the spring in which the cabbages are set it prevents the club-foot to a great extent, but if applied at the time of setting it has but little effect. A notable example of this was observed at Woodbury, N. Y., the present season. A large seed-bed for cabbage and cauliflower was given a heavy application of air-slaked lime just before the seeds were sown. Nearly all the plants became affected with club-foot.

IV. EXPERIMENTS AND OBSERVATIONS ON SOME DISEASES OF PLANTS.*

F. C. STEWART.

SUMMARY.

I. The popular opinion that green manuring with rye will prevent potato scab has been found, by experiment, to be without foundation in fact. Of the six plats employed in the experiment three were green manured with rye, while the remaining three (alternating with the rye plats) were used as checks. On all six plats the tubers were badly scabbed, the rye plats being even worse than the check plats.

II. An attempt to communicate the potato stem-blight by means of diseased "seed" failed. Unsuccessful attempts were made, also, to inoculate tomatoes, peppers, egg-plants, petunias and Chinese lantern plants by placing pieces of diseased tubers about their roots. The conclusion is that the disease is purely physiological and that there is no danger of spreading it by planting diseased tubers.

III. It has been shown by experiment that common salt solution applied to the foliage of carnations or to the soil in which they are grown will neither prevent rust nor give the plants a more vigorous growth.

IV. On Long Island it is unnecessary to commence spraying cucumbers (no matter what the date of planting) until the middle of July. In an experiment at Floral Park spraying increased the yield of early cucumbers at the rate of 30,450 fruits per acre.

Downy mildew is easier to control by spraying than is anthracnose.

*Reprint of Bulletin No. 138.

On Long Island downy mildew appeared earlier and was more destructive in 1896 than in 1897, although the rainfall for July and August was much heavier in the latter season. The high temperature of August 1-15, 1896, was probably responsible for the virulence of the disease in that year.

In an experiment at Woodbury an acre of late cucumbers which were sprayed eight times with Bordeaux mixture yielded 101,960 "pickles." The average yield of unsprayed cucumbers in this section was probably less than 20,000 per acre.

Plasmopara cubensis has been found on *Cucumis moschata* (winter crook-neck squash), which is a new host for this fungus.

I. PLOWING UNDER GREEN RYE TO PREVENT POTATO SCAB.

There appears to be a quite widespread notion among farmers that potatoes will be free from scab (*Oöspora scabies*) if grown on soil in which green rye has been plowed under just before planting. Some even assert that this method will insure a smooth crop of tubers on land which has produced a scabby crop the previous season.

It is highly important to know if this opinion has any foundation in fact, because at the present time there is no thoroughly practical method known for circumventing the evil influence of scab-infested soil. Halsted* has advocated the use of flowers of sulphur, applied to the "seed" and in the drills at the rate of about 300 pounds per acre, but for some reason farmers are unable, in practice, to confirm the results of his experiment.

Why green rye should have any power to prevent potato scab is not clear. Flagg,† assuming the rye theory to be true, has suggested, as a possible explanation, that the rye brings about an acid condition of the soil which is well known to be unfavorable to the growth of the scab fungus.

Although there appeared to be no good reason why green rye should possess the merits claimed for it, it was deemed worth while to test the matter by experiment; for experience has shown

*Halsted, B. D. Field Experiments with Potatoes. N. J. Agl. Expt. Stas. Bul. 112; and N. J. Agl. Expt. Stas. Rept. 1896, pp. 309-318.

† Flagg, C. O. Green Manuring and Potato Scab. *Cult. and Country Gent.*, Vol. LXI, p. 779.

that the popular opinions of the people concerning agricultural practice are usually based upon fact. Empiricism has often led science.

The experiment was made in coöperation with Messrs. White and Rice, of Yorktown, N. Y., and much credit is due these gentlemen for the painstaking manner in which they carried out the details of the experiment. The land used for the experiment was in a young plum orchard and was fairly, though not absolutely, uniform. In 1896 it had grown potatoes which were so scabby that a large part of the crop was unmerchantable. In October, 1896, the land was plowed and harrowed, and divided into six plats, lying side by side, as shown in the accompanying diagrammatic table. On October 12, rye was sown on three alternating plats, three other plats being left as checks. In spite of the lateness of seeding, the rye made a good growth, being about six inches high when plowed under, April 26, 1897. No fertilizer was used on any of the plats. The plats were planted April 28. Four rows were planted in each plat and exactly 175 pieces of "seed" (cut to two eyes) in each row. The "seed" consisted of slightly scabby tubers grown on the same land, and was of the variety Carman No. 1. In each plat two of the four rows were planted with tubers which had been soaked one and one-half hours in corrosive sublimate solution, containing $2\frac{1}{4}$ ounces of corrosive sublimate in 15 gallons of water. The remaining two rows in each plat were planted with untreated tubers.

Yield of Sound and Scabby Potatoes on Rye Plats and Check Plats.

Plats.	Manuring.	No scab.	Scabby but merchantable.	Unmerchantable.	Total.
		Lbs.	Lbs.	Lbs.	Lbs.
I.	Check	308	263	236	807
II.	Rye	211	162	321	694
III.	Check	248	216	319	783
IV.	Rye	154	198	248	600
V.	Check	229	182	134	545
VI.	Rye	161	212	224	597
	Total check plats	785	661	689	2,135
	Total rye plats	526	572	793	1,891

On all of the plats the potatoes came up well and produced a luxuriant growth of foliage. When the crop was harvested it was found that some of the tubers had rotted although the plants had received two applications of Bordeaux mixture, but the loss from rot was too small to materially affect the results so far as amount of scab is concerned.

It was found that the total yield of the three plats on which rye had been plowed under was 1891 pounds, while the total yield of the three plats which had no rye was 2135 pounds. The smaller yield on the rye plats appears to have been due to the rye. At least, it is safe to say that the rye had no tendency to *increase* the yield.

With reference to the amount of scab, the tubers were sorted into three classes: (1) Those entirely free from scab, (2) those which were scabby but merchantable, and (3) those which were so scabby as to be unmerchantable. The total yield of 1891 pounds on the rye plats was divided among these three classes as follows: No scab, 526 pounds; scabby but merchantable, 572 pounds; unmerchantable, 793 pounds. Classified on the same basis the yield of the plats without rye was distributed as follows: No scab, 785 pounds; scabby but merchantable, 661 pounds; unmerchantable, 689 pounds. From these figures it will be seen that plowing under rye did not decrease the amount of scab in the least, but on the contrary apparently *increased* it considerably.

From the results of this experiment, then, it appears that the practice of plowing under green rye to prevent potato scab is not to be recommended, inasmuch as it tends to increase rather than decrease the amount of scab and may, perhaps reduce the yield.

Concerning the value of the corrosive sublimate treatment, different plats gave different results, but on the whole the treated were fully as scabby as the untreated. This has been the almost universal experience and our experiment only serves to emphasize the uselessness of treating the "seed" with corrosive sublimate, if it is to be planted in scab-infested soil. The corrosive sublimate treatment did not reduce the yield.

II. THE COMMUNICABILITY OF POTATO STEM-BLIGHT.

The potato stem-blight herein discussed is the one described by the writer in Bulletin No. 101 of this Station, pp. 83-84. The symptoms of the disease, as there given, are as follows: "First, there is a cessation of growth. The topmost leaves take on a yellowish, or in some varieties a purple color, and roll inward from the edges and upward, exposing the under surfaces. This condition is followed by wilting and complete drying up of the entire foliage, the process taking from one to three weeks. The tubers appear to be sound, but, when cut at the stem-end, blackened fibers are seen penetrating the flesh to a considerable distance materially injuring it for cooking purposes. No rot develops in the tubers. The stem just beneath the surface of the soil first shows discolored spots and later becomes dry and shriveled."

This disease has continued to be destructive in 1896 and 1897, but the cause of it is still unknown. Formerly, a species of Oöspora was suspected of having some connection with it, but it is now very doubtful if any organism is responsible for the trouble. The portion of the stem which is below ground is quite evidently the seat of the disease, but no fungus hyphæ can be found in the tissues of this part of the plant in the early stages of the disease; neither are bacteria abundant, and the few which are found in the tissues may easily have gained entrance after the death of the stem. Numerous Petri-dish cultures of tissue from the interior of diseased stems were made with varying results. Because of the nature of the disease and the position of the diseased part it is very difficult to prevent the intrusion of foreign germs. While these cultures were in progress portions of diseased tubers were placed in moist chambers, but without exception they failed to develop any growth whatever. This gave rise to the suspicion that the disease may not be due to any organism but is purely physiological. It was, therefore, deemed advisable to determine, by experiment, whether the disease is communicable.

A quantity of badly diseased tubers was obtained and planted on land which had not grown potatoes for at least ten years. The tubers were cut with two eyes to each piece and care was taken that every piece planted showed some of the disease. Nearly every piece of "seed" produced a plant, but many of them were very slow about coming up. They appeared weak, were of divers sizes and, up to the time of blossoming, were considerably smaller than plants from healthy "seed" planted at the same time.

It was late in July before any of the plants showed symptoms of the disease, and at the close of the season only a few had had even a mild attack. When the tubers were dug just a few showed the characteristic blackening of the fibro-vascular bundles at the stem-end.

In spite of their slow growth in the early part of the season they yielded well. Five rows fifty feet long yielded 275 pounds of merchantable tubers which is equivalent to a yield of 266 bushels per acre. It is evident that they were not badly diseased.

Were the disease due either to fungi or bacteria, diseased tubers would, most likely, produce diseased plants. Since the disease is located in the subterranean stem, and to some extent in the tubers themselves, it is in the highest degree probable that the germs of the disease would become attached to the tubers and be distributed with them. The results of this experiment furnish strong evidence that the disease is not communicable, which is equivalent to saying that it is not caused by any vegetable organism. That the weather conditions were not unfavorable to the disease is shown by the fact that a potato field about thirty rods from the experimental potatoes was badly affected and the disease was common in various localities on Long Island. It should be stated, however, that the plants were thoroughly sprayed with Bordeaux mixture (eight or nine times in the course of the season); but it is scarcely possible that spraying could prevent a disease like this in which the seat of the trouble is certainly below the surface of the soil. Moreover, we observed,

in 1896, a potato field which had been sprayed five times and yet it was estimated that 33 per cent of the plants were affected by the disease.

Although the experiment shows that a fair yield of healthy tubers may be obtained from diseased "seed," we cannot recommend the practice of planting such "seed." Six 50-foot rows planted with healthy "seed" of the same variety and grown under parallel conditions, yielded 379 pounds of merchantable tubers, or at the rate of 305 bushels per acre, which is 39 bushels per acre above the yield from the diseased "seed."

Attempts were made to inoculate the disease upon other solanaceous plants. Badly diseased tubers were finely chopped and put into the soil close about the roots of 28 young tomato plants, 25 young egg-plants, 10 younger pepper plants (*Capsicum*), 10 young plants of the Chinese lantern plant (*Physalis franchetti*) and 6 young petunias. These plants were kept under observation throughout the season, but none of them showed any symptoms of a disease like the potato stem-blight. In fact, all of them except the petunias were remarkably healthy and productive. They, too, were occasionally sprayed with Bordeaux mixture.

III. EFFECTS OF COMMON SALT ON THE GROWTH OF CARNATIONS AND CARNATION RUST.

Some florists have advocated the use of an aqueous solution of common salt (sodium chloride) on carnation foliage. The salt solution is to be applied in the form of a fine spray, and it is believed that the plants are benefited in two ways; (1) by preventing the attacks of rust (*Uromyces caryophyllinus*), and (2) by giving the plants a more vigorous growth.

Some experiments which we have conducted during the past three years lead us to believe that salt solution is worthless for either of the above purposes. In a previous bulletin* we have reported a spraying experiment on carnations in which salt solution (8 lbs. to 45 gals. of water) applied once a week, failed to prevent rust in the least, every plant showing rust at "lifting" time; neither did the plants seem to be any more vigorous or

* New York Agl. Exp. Sta. Bul. 100, pp. 56-62.

to have made any better growth than unsprayed plants of the same variety standing beside them. This experiment was made in 1895. In 1896 it was repeated, but no rust appeared on any of the plants, not even on the unsprayed ones, so that this season's experiments gave no additional evidence as to the value of salt spray as a preventive of rust; but it was again observed that the sprayed plants made no better growth than the unsprayed ones.

In addition to the spraying experiment in 1896, another experiment was made to determine the effect of adding salt to the soil in which carnations are grown. On May 18, 1896, 50 rooted cuttings, of the variety Uncle John, were potted in six-inch pots which were sunk in the soil out of doors. They were divided into five lots of ten plants each and treated, at intervals of about two weeks, with different quantities of a two and one-half per cent salt solution as follows:

Lot I. 10 c. c. salt solution, or 0.25 gram of salt per plant;
Lot II. 40 c. c. salt solution, or 1 gram of salt per plant;
Lot III. 80 c. c. salt solution, or 2 grams of salt per plant;
Lot IV. 200 c. c. salt solution, or 5 grams of salt per plant;
Lot V. Check. Not treated.

The salt solution was poured upon the surface of the soil in the pot around the base of the plant and allowed to soak down. The dates of application were as follows: June 2, 16, 30, July 14, 29, August 24, September 9 and 26.

As in the spraying experiment of the same season, no rust appeared. At the conclusion of the experiment the plants were examined by an expert carnationist who did not know how the different lots had been treated and hence could not possibly have been prejudiced. He decided that the plants in Lot V had made considerably the best growth; that Lots I and II were about equal and second best; while Lots III and IV were about equal and poorest. It was very evident that the salted plants had made a less vigorous growth.

In 1897 the experiment was repeated. As before, the plants were of the variety Uncle John, potted on May 18 in six-inch pots which were sunk in the soil out of doors; there were ten

plants in each lot; and the same quantities of a two and one-half per cent solution were used. This time, however, Lot I was omitted.

The dates of applying the salt solution in this experiment were as follows: May 18, 28, June 11, 25, July 9, 23, August 7, 20, September 3.

All of the salted plants were again smaller than the unsalted ones. On August 27 four average plants of each lot, still in the pots, were removed to the greenhouse. Up to this date no rust had appeared, but on September 17, when the plants were next examined, every one was found to be rusty. From this time on the rust made rapid progress and became even worse on the salted plants than on the unsalted.

These experiments show that it is useless to try to prevent rust by the use of salt solution, applied either to the soil or to the foliage, and, also, that salt is not an aid to the growth of carnations.

IV. FURTHER EXPERIMENTS ON SPRAYING CUCUMBERS.

Spraying Early Cucumbers.

In the Long Island market gardens cucumbers are divided into two classes—early cucumbers and late cucumbers. The former are planted as soon as danger of frost is past in spring, and the fruits, which are allowed to attain a length of from five to seven inches, are sold in the city markets to be eaten fresh. Late cucumbers are planted from June 25 to July 4, and the fruits are gathered when they are from two and one-half to three and one-half inches in length. They are used for pickling purposes, and for the most part are sold directly to pickle manufacturers who have established salting houses at various points in the farming districts.

The spraying experiment reported in Bulletin No. 119 of this Station was made on late cucumbers. In 1897 the following experiment was made on early cucumbers. Eight rows of 25 hills each were planted early in May. The rows were five feet apart and the hills four feet apart in the row. The variety was White

Spine. When the plants were well started they were thinned to four in a hill. Throughout the whole season four of the eight rows were kept well covered with Bordeaux mixture (1-to-8 formula) by frequent sprayings, while the other four rows were not sprayed at all. Spraying was commenced almost as soon as the plants were out of the ground, in order, if possible, to prevent the ravages of the striped cucumber beetle, *Diabrotica vittata*. For this reason Paris green was added to the Bordeaux mixture used in the first three sprayings. The dates of spraying were: May 28, June 1, 11, 22, July 2, 12, 16, 23, 30, August 7, 13, 20, 27, and September 7. In all, the plants were sprayed fourteen times and each time carefully so that the spraying was of the most thorough kind.

The weather was unfavorable for cucumbers, still they grew fairly well. The first disease to make its appearance was a bacterial wilt disease which commenced its ravages about August 2, and during the two weeks following killed perhaps 50 plants on the unsprayed plat and only five or six on the sprayed plat. On August 11 there were traces of anthracnose, *Colletotrichum lagenarium*, on the unsprayed plat and from August 24 to the end of the season this disease was very destructive on the unsprayed plat and also did some damage on the sprayed plat, particularly toward the close of the season. The downy mildew made its first appearance August 24 on the unsprayed plat where it spread rapidly and did much damage, but it did not attack the sprayed plat.

A careful record was kept of the number and weight of the fruits produced on the two plats. At each picking only those fruits which were more than three inches long were gathered. In other words, the fruits were allowed to attain a considerable size and most of them would pass in the market for "cucumbers" as the large fruits are called to distinguish them from "pickles" which are the small fruits used for pickling. The sprayed plat yielded 3,263 fruits which weighed 1,159 pounds; while the unsprayed plat yielded 1,866 fruits, having a weight of 590 pounds. Expressed in more familiar terms, the yield per acre on the sprayed plat was at the rate of 71,100, weighing 25,265 pounds;

on the unsprayed plat at the rate of 40,650, weighing 12,860 pounds. Hence, the increase in number of fruits per acre due to spraying was 30,450, and the increase in weight 12,405 pounds.

The following table gives the number and weight of the fruits gathered at each picking:

YIELD OF CUCUMBERS FROM SPRAYED AND UNSPRAYED PLATS.

DATE.	SPRAYED.		UNSPRAYED.	
	Number.	Weight.	Number.	Weight.
		Lbs.		Lbs.
July 26	16	3.25	31	9.50
August 2	89	22.25	112	28.25
August 7	184	60.25	155	57.25
August 11	184	60.50	158	54
August 16	378	139.75	269	109.50
August 20	256	96	220	70.50
August 24	322	99	236	72
August 27	234	73	124	32
August 31	370	157	241	80
September 4	298	117	108	32
September 8	300	128	87	17
September 10	151	38	43	8
September 14	288	105	44	11
September 18	193	60	38	9
Totals	3,263	1,159	1,866	590

It is important to observe that in the first two pickings the unsprayed plants yielded more than the sprayed. This shows that at the beginning of the experiment the unsprayed plants had at least an equal chance with the sprayed, so that the differences which appeared later may be justly attributed to the spraying. Moreover, it shows that up to the close of July there was no appreciable benefit from spraying, and this means that the six applications made prior to July 15 were unnecessary. Spraying deterred the striped cucumber beetles but slightly and this small benefit was counterbalanced by the injurious effect of the Bordeaux mixture on the growth of the young plants. There was no discoloration of the foliage such as occurs when the Bordeaux is improperly prepared, but the sprayed plants were somewhat smaller for a considerable length of time. All observations go to show that spraying (on either early or late cucumbers) need not be commenced until after July 15. The past season there was scarcely a trace of anthracnose on cucumbers anywhere on

Long Island until after August 1, and downy mildew did not appear until three weeks later. The time of appearance of both these diseases is more dependent upon the weather conditions than upon the stage of growth of the plant. Both early and late cucumbers are attacked at about the same time.

The very thorough spraying which the plants received gave complete protection against downy mildew but only partial protection against the anthracnose. In the latter part of the season there was sufficient anthracnose among the sprayed plants to seriously affect the yield. By consulting the table on page 427, it may be seen that the last picking was made September 18, whereas there was no frost until September 28. After September 18, the anthracnose became so severe on the sprayed plat that the plants dried up and produced thereafter only deformed fruits or "nubbins." From this it appears that anthracnose is more difficult to manage than downy mildew, and that to prevent it the spraying must be done very thoroughly and repeated at short intervals. Of course this test was a severe one because of the close proximity of the diseased plants on the unsprayed plat.

An unexpected result of the experiment was the influence which the spraying *seemed* to have in checking the wilt disease. The wilt disease killed about fifty plants on the unsprayed plat and only five or six on the sprayed plat. Considering the small size of the plats this difference is worthy of note.

Until near the close of the season the percentage of deformed fruits produced by the sprayed plants was very small—much smaller than in the case of the unsprayed plants.

WHY *Plasmopara cubensis* WAS MORE ABUNDANT IN 1896 THAN IN 1897.

Halsted* has published observations which indicate that the Peronosporeæ, in general, thrive best in wet seasons. For *Plasmopara cubensis* no such observations have been recorded, but from the following it appears that this fungus is influenced more by temperature than by rainfall.

*Halsted, Byron D. Downy Mildews in a Dry Season. Bulletin from the Botanical Department of the Iowa Agricultural College, 1888; and, Peronosporeæ and Rainfall. Journ. Myc., Vol. V, pp. 6-11, 1889.

In 1896, *Plasmopara cubensis* made its first appearance on Long Island about August 7. In 1897 it did not appear until August 24, and was not nearly so destructive as in 1896. Without doubt this difference was due to some difference in the weather conditions prevailing during the two seasons, and inasmuch as August is the month in which the fungus commences its ravages, it is likely that the variable factor should be sought in the weather records of that month. The New York State Weather Bureau has stations on Long Island at Brooklyn, Willets Point, Brentwood and Setauket. A comparison of the records of these stations for August, 1896, with the records of the same stations for August, 1897, shows that the only important difference is in the temperature for the first fifteen days of the month. This difference is brought out in a striking manner in the following table of daily mean temperature* which shows that the average temperature for the first half of August, 1896, was 7° higher than for the same period in 1897.

TEMPERATURE RECORD, AUGUST 1–15, 1896 AND 1897.

DATE.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
August, 1896	67°	72°	72°	78°	80°	78°	81°	81°	83°	83°	83°	83°	82°	76°	75°
August, 1897	72°	74°	73°	72°	66°	70°	71°	70°	69°	71°	73°	71°	69°	72°	76°

The rainfall for August was somewhat greater in 1897 than in 1896, and this alone should be sufficient evidence that the rainfall is not the controlling factor in the development of downy mildew. However, if it is desired to go back to the month of July we find that 1897 was much the wetter. The records are as follows:

RAINFALL RECORD, JULY AND AUGUST, 1896 AND 1897.

	July 1896.	August 1896.	July 1897.	August 1897.
	Inches	Inches.	Inches.	Inches.
Brooklyn	4.23	3.22	11.06	4.10
Willets Point	5.79	1.64	9.75	2.26
Brentwood	4.70	4.20	10.00	2.10
Setauket	2.74	2.35	18.18	5.03

*Computed from records published in Report of the New York State Weather Bureau, Vol. VIII, No. 8, p. 8, and Vol. IX, No. 8, p. 8.

ONE HUNDRED THOUSAND CUCUMBERS FROM AN ACRE OF SPRAYED PLANTS.

In the spraying experiment against the downy mildew made at Woodbury, Long Island, in 1896, and reported in Bulletin No. 119, the protection against the disease was not complete. Toward the close of the season the downy mildew became quite abundant on the sprayed plats. The infection came, of course, from the badly diseased plants in the adjoining rows which had not been sprayed. In practice, no unsprayed rows would be left and it is reasonable to expect even better results than were obtained in that experiment.

For the purpose of ascertaining to what extent the disease can be controlled when an entire field is sprayed, the following experiment was made at Woodbury, on the farm of Mr. R. C. Colyer, the gentleman who coöperated with us in the experiment made in 1896. In a meadow of clover and timothy, equal parts, an exact acre of land was selected. The grass was removed about June 20 and the land immediately plowed and spread with barnyard manure. It was then thoroughly harrowed with a disc harrow and marked out 3½ by 4 feet. Next Mapes' Fruit and Vine fertilizer, 1,000 pounds, was drilled into the rows, 400 pounds of kainit sown on broadcast and the field again harrowed.* The seed, which was of the variety Early Cluster, was planted June 26th. On account of heavy rains it was necessary to do considerable replanting, some hills being replanted twice, but eventually nearly a full stand was obtained. The acre was sprayed eight times with Bordeaux mixture (1-to-8 formula), applied with a knapsack sprayer. The dates of spraying were as follows: July 22, 30, August 7, 16, 25, September 4, 13, and 20. A killing frost occurred on the night of September 28.

The cucumbers were contracted to the H. J. Heinz Company, which has a factory at Hicksville, at $1.50 per thousand for the larger ones and 75 cents per thousand for the small ones, or gherkins. Below is the factory record of receipts from the experiment acre:

*It should not be assumed that the Station recommends this method of manuring. The manuring and preparation of the land were left entirely to the judgment of Mr. Colyer, who was instructed to "put the land in proper condition to grow a good crop of cucumbers."

CUCUMBERS FROM SPRAYED ACRE, SOLD TO PICKLE FACTORY.

DATE.	Number of fruits of the proper size for pickles.	Number of small fruits or gherkins.
August 14	80	50
August 16	200	300
August 18	400	75
August 20	750	650
August 23	2,050	1,225
August 25	2,225	1,335
August 28	2,925	1,220
August 30	5,040	1,655
September 1	3,575	1,000
September 3	3,900	1,450
September 6	7,350	3,025
September 9	3,230	1,410
September 11	6,400	1,600
September 14	4,700	2,065
September 16	2,350	1,590
September 18	3,900	1,900
September 21	4,160	2,000
September 23	1,675	6,075
September 27	700	3,225
Total	55,610	31,850

To the above number must be added 1,500 large ones and 13,000 small ones which were gathered on September 29th, the day after the frost. These were sold in Wallabout market, Brooklyn, because no cucumbers would be received at the factory after frost. They brought $19.

Summarized, the results are as follows:

55,610	large "pickles" at $1.50 per thousand	$83 40
31,850	small "pickles" at 75 cents per thousand	23 85
13,000	small "pickles" } Sold at Wallabout for	19 00
1,500	large "pickles" }	
101,960		$126 25

When frost came the plants were entirely free from downy mildew and anthracnose, although both of these diseases were abundant in most of the cucumber fields in the vicinity. The nearest source of infection was an unsprayed muskmelon patch about thirty rods distant.

Ordinarily, 100,000 cucumbers per acre would not be considered a large yield but for the past season it is uncommonly large. The average yield per acre of cucumbers on Long Island in 1897

was smaller than in 1896, when it was about 20,000 per acre. In some sections the crop was almost a total failure. In 1896 the downy mildew was by far the principal enemy, but in 1897 it seemed as if all of the enemies of the cucumber had combined for its destruction. The weather was very unfavorable, and downy mildew, anthracnose and the bacterial wilt disease were all destructive. Indeed, it was impossible to determine which of these four causes was responsible for the most damage.

SHADE AS A PREVENTIVE OF DOWNY MILDEW.

It is a matter of common observation that down mildew is less destructive to cucumber plants which are partially shaded; for example, plants growing under trees or in weeds and particularly portions of vines which run out into the grass and tall weeds at the borders of the field.

It was attempted to make a practical application of this fact by planting rows of sweet corn alternately with rows of cucumbers. Rows of sweet corn were planted five feet apart, and when the corn was a few inches high rows of cucumbers were planted between the corn rows. On the same date other hills of cucumbers without the corn were planted close by for comparison.

As might have been expected, the unshaded plants made considerable better growth than the shaded. There seemed to be no difference in the amount of anthracnose, only a slight difference in the amount of downy mildew, and the bacterial wilt disease was decidedly more destructive among the shaded plants.

It seems improbable that shade can be advantageously employed as a preventive of down mildew.

A NEW HOST FOR *Plasmopara cubensis*.

The recorded hosts of *Plasmopara cubensis* are as follows:

(1) "On leaves of some cucurbitaceous plant"* (from Cuba);

(2) *Cucumis sativa* L. (cucumber);†

* Berkeley, Rev. M. J. and Curtis, Dr. M. A. Fungi Cubenses. Journ. of the Linnaean Soc. Botany X, p. 363, 1869.

† Farlow, W. G. Notes on Fungi. Bot. Gaz., XIV, p. 189, Aug., 1889.

(3) *Cucurbita maxima* Duchesne (squash);*

(4) *Cucurbita pepo* L. (pumpkin);†

(5) *Citrullus vulgaris* Schrad. (watermelon);‡

(6) *Cucumis melo* L. (muskmelon);§

(7) *Cucumis anguria* L. (gherkin gourd).||

To this list of hosts must now be added *Cucumis moschata* Duchesne (winter crook-neck squash) on which the fungus was found in abundance at Floral Park, N. Y., during the past season.

*Halsted, Byron D. Some Notes upon Economic Peronosporeæ for 1889 in New Jersey. Journ. of Myc., 5, p. 201.

†Halsted, Loc. cit.

‡Halsted, Byron D. Notes upon Peronosporeæ for 1891. Bot. Gaz., XVI, p. 339. Dec., 1891.

§Halsted, B. D. Report of the Botanist. Fourteenth Ann. Rept. N. J. State Agr. Exp. Sta. and the Sixth Ann. Rept. of the N. J. Agr. Coll. Exp. Sta. for the year 1893, p. 352.

||Swingle, W. T. Some Peronosporaceæ in the Herbarium of the Division of Vegetable Pathology. Journ. of Myc., VII, p. 125, 1892.

REPORT

OF THE

DEPARTMENT OF ENTOMOLOGY.

Entomologists.

VICTOR H. LOWE, B. S.

F. A. SIRRINE, M. S.*

* At the Branch Station in Second Judicial Department.

Table of Contents.

REPORT OF THE ENTOMOLOGISTS.

I. INSPECTION OF NURSERIES AND TREATMENT OF INFECTED NURSERY STOCK.*

V. H. LOWE.

SUMMARY.

Most of the nurseries inspected have been found practically free from insect pests of a serious nature. Ten important species have been found at different times, however, in sufficient numbers to do serious injury. In all cases efforts were at once made to clean out the stock thus infested. The most important insect which attacks nursery stock in this State is the San José scale. It is important to nurserymen not only because of the injury which it may do to the infested stock, but because it is greatly dreaded by both dealers and fruit growers alike. Hence, stock from a nusery which is known to have been once infested does not find a ready sale.

Experiments in dipping and spraying young nursery trees indicate that plant lice may be controlled in the nursery by dipping the curled tips of infested trees in a solution of whale oil soap, one pound to seven gallons of water. The work should be done early in the season. Flea beetles attacking young pear and apple trees may be held in check by spraying with green arsenite, one pound to 100 gallons of water, and the canker worm will succumb to the same treatment.

The experiments in fumigating nursery stock with hydrocyanic acid gas, when the stock is piled in the cellar for winter storage, indicate that this method may prove practical, thus avoiding the necessity of building special fumigating houses.

*Reprint of Bulletin No. 136.

INTRODUCTION.

In the spring of 1896, the Maryland Legislature passed a law providing that all nursery stock shipped into that state must be accompanied by a certificate. This certificate must state that the stock has been duly inspected by an authorized official and pronounced by him free from indications of the presence of dangerously injurious insects and plant diseases. It is stated that this law was for the especial purpose of protecting Maryland fruit growers from the further importation into their State of that much-dreaded pest, the San José scale. Other States followed suit until seven now have similar laws and the question of similar legislation is being agitated in as many more.

Owing to this agitation and also to the fact that much has been said and written about the San José scale, its rapid work as a destroyer of fruit trees and shrubs and the ease with which it can be transported on nursery stock, Western New York nurserymen soon found themselves in a position where it was necessary to have their nurseries inspected or be seriously handicapped by the inspection laws of other states.

Although there was no evidence of an organized effort on the part of the nurserymen to have the work of inspection put upon a proper basis, the Station at once undertook to accommodate them and has endeavored to do so as far as possible during the past two years.

That there will be still further need of nursery and orchard inspection in the State seems very probable. The San José scale has been found in abundance in some sections of the State and has already shown that it can thrive in Western New York. The fact, also, that a small nursery has been found in the western part of the State and others in the southeastern, in which the scale has been thriving for several years, indicates that this insect may have a much wider distribution within our borders than is at present suspected. This seems all the more probable when we reflect that just over the line in Canada the scale has been found in a number of orchards and it is known to occur in states bor-

dering New York on the east, south and west. At present there is no law to hinder the importation of infested stock from all of these directions and no provision made for a systematic effort to prevent the further spread of this and similar pests within the State.

The insects discussed in this bulletin have been found in more or less abundance in the nurseries from time to time. All of them are readily transported on nursery stock and hence are of importance to the nurseryman as well as the fruit grower.

The problem of how best to control the numerous species of insects which attack the growing plants in the nursery is a very important one. The few experiments noted in this bulletin are incomplete, but it is expected that as opportunity is afforded they will be continued until more definite results are reached. This work will be greatly aided by the increased facilities at the Station.

INSPECTION OF NURSERIES IN WESTERN NEW YORK.

METHOD OF INSPECTION.

The immediate surroundings of the nursery were first noted and any old neglected orchards bordering on the nursery, or neglected blocks of stock were first carefully examined. On several occasions neglected apple orchards or a few old neglected apple trees were found badly infested with various species of injurious insects, principally the woolly aphis. Further examinations showed that many of the nursery trees in the immediate vicinity were infested with the same species, the indications being that the insects had originally come from the old trees. After the orchard trees were examined the condition of the more immediate surroundings of the blocks, such as the fence corners, etc., were noted and any suspicious looking shrubbery subjected to a careful scrutiny. The nursery rows were next examined, the usual method being to go back and forth across the rows a number of times until the general appearance of the trees was well noted. All suspicious looking trees were, of course, carefully examined. Where possible, the examination was repeated two or three times during the season.

VALUE OF INSPECTION.

It is a difficult matter to estimate the real value of nursery stock inspection. Very much depends upon the care with which the work is done. Judging from our own experience and from the work that is being done in other states, inspection which includes not only the nursery but the orchard as well, properly carried out, can be depended upon to bring to light the worst cases, at least, of infestation by the San José scale and other insects and plant diseases of a seriously injurious nature. Judging from our observations one of the chief benefits which has thus far resulted from nursery stock inspection in this State, is to make the growers and dealers more careful as to the condition of the stock sent out. It is probably not overestimating the value of nursery and orchard inspection to say that, properly carried out, it will be a constant stimulus to the production of clean, healthy stock, and will result in effectually holding in check such dreaded pests as the San José scale.

THOSE BENEFITED BY INSPECTION.

If inspection has a tendency to bring a better class of nursery stock on the market, then it is evident that not only the nurserymen, but all interested directly and indirectly, in the growing of trees, shrubs and vines are more or less benefited thereby. Where the inspection is extended to the orchard the benefit is much greater. Farmers should keep this in mind and note carefully the condition of the trees when they come from the nursery and watch for the development of injurious insects and diseases. In this way each farmer can be the inspector for his own premises. Nurserymen have usually considered inspection something of an annoyance but cheerfully take the necessary steps for their own benefit and to satisfy their customers.

A GROWING DEMAND FOR INSPECTION.

As previously stated, several states have recently passed inspection laws similar to the Maryland law. Hence all nurserymen doing business in these states require certificates in order to

prevent serious interference with their business. These restrictions to the trade have created a demand for nursery stock inspection which is far too great for a station entomologist to meet properly without aid if he expects to carry on his regular work. We found the demands for this kind of work so heavy during the past season that, in order to prevent a too serious interference with other duties, it was necessary to restrict our inspection for the most part to Ontario County alone. As yet no provision has been made either by State or federal law to meet this urgent demand of a highly important industry.

VARIETIES OF TREES, SHRUBS AND VINES EXAMINED.

It is not necessary to give a list here of the varieties of trees, shrubs and vines examined. It is safe to say that practically all the varieties of plants grown as nursery stock in Western New York, both in the field and under glass, were examined on different occasions. By far the greater part of the stock inspected, however, consisted of the various varieties of fruit trees.

VARIETIES OF TREES MOST COMMONLY INFESTED.

These were the apple, peach and pear trees. The apple and pear trees were most commonly infested with the woolly aphis, and this pest was most often found on the Ben Davis and Yellow Transparent apples and upon the standard pears. In most cases of infested pear trees, the blocks were next to blocks of infested apples, the indications being that the insects had come from the apples to the pears. The peach trees were infested with the peach-tree borer.

SPECIES OF INSECTS INCLUDED IN THIS REPORT.

Only the more important species which are readily transferred on nursery stock are included in this report. No account is taken of the large number of species which attack the stock during the growing season but which do not remain on the trees after the leaves are taken off and hence are not readily scattered over the country by means of nursery stock.

For convenience the species herein discussed may be grouped under four heads as follows:

I. Insects which secrete or otherwise produce a scale-like covering .... SCALE INSECTS, including the oyster-shell bark-louse, scurfy bark-louse, the New York plum lecanium, the oak scale and the San José scale.

II. Insects which secrete honey dew or a bluish-whie flocculent substance .... PLANT LICE, including the woolly aphis of the apple.

III. Insects which bore into the trees.............. BORERS, including the peach-tree borer.

IV. Insects which feed on the buds and leaves and which hibernate on the twigs in protective cases........... CASE-BEARERS, including the pistol-case-bearer and the cigar-case-bearer. Although not a true case-bearing insect the bud moth may for convenience be included under this head.

SCALE INSECTS.

Scale insects are among the most common of the insect pests. The group includes a large number of species. As destructive insects they rank among the first and are to be dreaded, not only because of the great injury which they can inflict, but because most species are very hard to eradicate from a nursery or an orchard after they have once become well established. As a rule, however, scale insects need not become abundant in the nursery if the stock is carefully watched and the first few trees found infested are either treated or burned. The most important species found are discussed in detail as follows:

THE OYSTER SHELL BARK LOUSE.

Mytilaspis pomorum Bouché.

This insect is so commonly found in the orchard that it is liable to be considered of little importance. It is less harmful than many other scale insects yet it is capable of doing very serious injury, especially in the young orchard, and for this reason should be considered an important pest in the nursery, even though the nursery trees themselves do not usually become badly infested.

History.—But little is known of the early history of this species. According to our best authorities it is undoubtedly of European origin but was introduced very early into this country. It was first described in 1738 by a Frenchman named Reaumer who found specimens on an elm in his native country. According to Dr. Howard* it was known in this country as early as 1794.

The earliest account which we have seen relating to the insect in this State was published by Dr. Asa Fitch in 1856 in his first report as State Entomologist (p. 31). Dr. Fitch states that the insect was then known "everywhere through the northern states . . . infesting the orchards to a grievous extent, causing the death of many trees and impairing the health and vigor of many more." The same writer quotes a Wisconsin correspondent who states that the insect was evidently introduced into Wisconsin as early as 1840. It is thus shown that the species had a wide distribution in this country at an early date.

Present distribution.—The oyster-shell bark-louse is known all over the world. It occurs in more or less abundance wherever apples and pears are grown. In the United States it is reported from Maine to California, although it is not so well known in many of the western states as in the east and south. It is widely distributed throughout this State. While we are receiving specimens from new localities every year, up to the present time specimens have been received from the following counties: Erie, Niagara, Monroe, Wayne, Ontario, Yates, Schuyler, Seneca, Cayuga, Onondaga, Cortland, Jefferson, Lewis, St. Lawrence, Columbia, Kings, Queens and Suffolk.

Food plants.—The list of food plants for this insect includes a large number of our common trees and shrubs. In the nursery it is especially abundant upon fruit trees, such as apple and pear, but it should be watched for on other stock such as currant, gooseberry, blackberry and raspberry, also on ornamentals such as maple, birch, elm and lilac.

Descriptions and life history.—The life history of the oyster-shell bark-louse is very similar to that of many other species of scale insects. If an infested tree is examined in the winter the

*Year Book U. S. Dept. Agr. 1894, p. 255.

scales will be found to present the appearance shown in Plate XIX, fig. 1, which is from a photograph of an infested apple twig, natural size. It will be observed that although differing in shape, being longer and narrower, the scales bear a slight resemblance to an oyster-shell, hence the name. If one or two of these scales are turned over [Fig. 2.] they will be found to be well filled with creamy white eggs. If, however, the eggs are not observed until nearly ready to hatch they will have turned to a dark reddish-brown color. There are usually between forty and fifty, although the number may vary greatly. We have found as few as thirty and more than sixty under different scales. The shriveled body of the female scale will be found occupying a portion of the smaller end. The eggs vary in shape as shown at Fig. 3, which is from a photomicrograph showing a number of the eggs greatly enlarged, but in general appearance slightly resemble miniature hens' eggs. They also vary in size, but from a number of measurements we found that an egg of average size would measure about 0.3 mm. by 0.18 mm.

The eggs remain protected by the scales all winter. In this climate most of them have hatched by the first of June. In some seasons they hatch earlier than others. Last year many newly hatched lice were observed on apple trees in the vicinity of the Station as early as May 7.

The newly hatched lice are very small, measuring only about 0.4 mm. in length and half as broad. A good idea of their shape is given in Plate XX, fig. 1, *c*. Their bodies are nearly flat and light yellow in color. They wander about for a short time, varying from a few hours to a day or more, finally settling down, most of them on the new growth, where they begin to suck the sap by means of their sharp, thread-like mouth parts. They probably never go to the leaves and only one or two cases have been reported where the scales were found on the fruit. It is probable that when once settled on the bark the females never move.

The scales grow rapidly and by the latter part of July are mature. Most of the scales grow to have the appearance already

referred to and shown at Plate XIX, fig. 1. These are the female scales and they are in a very large majority. The male scales are much smaller, and more regular in outline. The posterior portion of the scale is also very different in that it is hinged so as to allow the mature male to escape.

In color, the male and female scales are similar, both finally becoming an ash gray tint. The mature male is a delicate two-winged insect very different in appearance from the female. A mature male is shown in Plate XX, fig. 1, *a*, and a mature female, with her scale removed, at *e*.

The eggs are laid during the middle of the summer, the body of the female growing smaller as each one is produced until finally there is little left but a withered skin. The eggs remain under the scales all winter, finally hatching in the spring as previously stated.

Means of distribution.—As the scale passes the fall, winter, and part of the spring in the egg stage, the eggs being protected by the scales, it is evident that the insect may be easily distributed by means of infested stock. When the trees are not badly infested the scales are easily overlooked, and thus as each scale protects thirty or forty eggs, a nursery tree even slightly infested may finally harbor enough scales to do very serious injury in the orchard.

Remedial measures.—Badly infested nursery trees should be dug up and burned. Where especially choice trees or shrubs are infested they may be successfully treated either by applying a wash during the winter or by spraying in the spring while the young lice are active. For a winter wash either kerosene emulsion or whale oil soap may be used. The kerosene emulsion should be diluted with three parts of water, and the whale oil soap* used at a strength of one pound to two gallons of water.

Before applying the wash the infested parts should either be scraped gently or rubbed with a stiff scrubbing brush to loosen the scales. This allows the insecticide to reach the eggs which would otherwise be protected by the scales. For spring treat-

*In buying whale oil soap much pains should be taken to get a good article. Much of the soap on the market is very poor. The Leggett brand has proven of good quality, also that manufactured by Jas. Good, Philadelphia, Pa.

ment, spray the trees as soon as the young lice appear. Either kerosene emulsion or whale oil soap solution may be used. The former should be diluted with seven parts of water and the latter used at a strength of one pound to seven gallons of water.

Where practical the winter treatment is preferable, as many of the young scales may be easily missed. In case of badly infested trees, however, both the winter and spring treatment may be given with excellent effect.

THE SCURFY BARK-LOUSE.

Chionaspis furfurus Fitch.

Like the oyster-shell bark-louse, this species occasionally becomes sufficiently abundant to do serious injury. We have seen it in the nursery as often as the other species, and have found it doing very serious injury in at least one large pear orchard in the State.

History.—Although this species is less frequently mentioned in the writings of early American entomologists, it was well known at an early date as an injurious species. B. D. Walsh and other writers on American entomology mentioned it as early as 1860. Since that time it has been frequently mentioned by American writers.

Present distribution.—According to Dr. Howard* this species is now known to occur in the District of Columbia and twenty states, including Massachusetts on the east, Georgia on the south and southern California on the west. The same writer also states that it has been recently reported in England. It is undoubtedly widely distributed in this State. Up to this date we have received specimens from Erie, Niagara, Monroe, Wayne, Ontario, Yates, Schuyler, Seneca, Cayuga, Onondaga, Columbia, Queens and Suffolk counties.

Food plants.—The most common food plants for the scurfy bark-louse are apple and pear. In the nurseries we have found it more abundant on pear trees than on any other stock. In one instance nearly all the trees in a small block of standard pears

*Year Book U. S. Dept. Agr. 1894, p. 259.

were very badly infested, a majority of them being seriously injured. We have found it upon apple, pear, crab apple and quince. In addition to these food plants Dr. Howard* gives black cherry, choke cherry, currant, mountain ash, Japan quince and peach, the last named having been sent from two localities in Georgia.

Descriptions and life history.—The general appearance of the mature female scales is shown in Plate XIX, Fig. 4, which is from a photograph of an infested pear twig. They are dirty white in color. The life history of this species is very similar to that of the oyster-shell bark-louse. The eggs are found under the scales during the winter, but usually in less numbers than in the preceding species; also, instead of being cream white, they are purplish red. The young scales hatch in the spring at about the time the young oyster-shell bark-lice appear, which they resemble very closely. The male scales are much smaller than the female scales, and, unlike them, are brilliant white. They are also quite different in shape, the sides being nearly parallel with two longitudinal ridges extending along the upper surface.

Means of distribution.—This insect is distributed by means of infested nursery stock in the same manner as the preceding species. Owing to their lighter color, however, they are more easily seen, and hence there is less excuse for sending out infested stock.

Remedial measures.—The treatment recommended for the oyster-shell bark-louse will prove equally effective for this insect.

THE NEW YORK PLUM LECANIUM.

Lecanium cerasifex †Fitch(?).

The sudden appearance of this insect three years ago in overwhelming numbers in some of the large plum orchards of western New York is, doubtless, fresh in the memory of orchardists and nurserymen throughout the State. Very little is heard of this scale now, however, owing to the fact that it disappeared almost as suddenly as it came. But it may still be seen occasion-

*Year Book U. S. Dept. Agr. 1894, p. 260.
†Identified by Mr. Th. Pergande.

ally in most plum orchards and during the past season we found it scattered in several nurseries, hence it may yet be considered a pest which should be carefully watched with a view to preventing other serious outbreaks.

History.—Previous to 1893 but little was known of this insect in this State, although it seems to be the prevailing opinion among prominent fruit growers that the insect has been in the plum orchards of western New York for twenty years or more, but not in sufficient numbers to cause special comment. During the seasons of 1893 and 1894 the insect did great damage to western New York plum orchards, but in the spring of 1895 comparatively few of the scales could be found, most of them having succumbed to the attacks of parasites, predaceous insects and climatic changes.

Present distribution.—Accurate data as to the present distribution of this insect is wanting. This or a very similar species, however, is known in the south and a species which is probably identical is reported from England. Judging from our observations during the past season, the scale is at present scattered through many of the larger plum orchards in western New York and may be occasionally seen in the nurseries, but in only a few cases have we found it in sufficient numbers to do serious injury. We have observed the species in the following counties: Niagara, Orleans, Genesee, Monroe, Ontario, Seneca, Cayuga, Onondaga, Richmond and Queens.

Food plants.—As its name indicates, this species is especially injurious to the plum. It has also been reported upon apple, pear, maple, *Cissus*, cherry and peach. In addition to these food plants the writer has found a very closely allied if not identical species upon quince, apricot, cultivated blackberry, cultivated grape, honey locust, black ash and iron wood [*Ostryia*].

Descriptions and life history.—A detailed account of this insect is given in the Fourteenth Annual Report of this Station, pages 574-593. As comparatively few of the reports are left for distribution, however, it may be well to repeat the life history of the insect substantially as given therein.

The general appearance of the insect is shown at Plate XIX, fig. 5. At *a* the mature scales are shown enlarged and at *b* the mature and young hibernating scales, natural size. Unlike the two preceding species, this scale passes the winter in the larval state. After the first few warm days of spring, the young scales begin to move about, but soon find a suitable place to settle down to again suck the sap of their host plant. They soon begin to grow with astonishing rapidity. Previous to this time the male and female scales are very much alike, but as the season advances the female scales are seen to grow to large oval fleshy scales, while the males are much smaller, oblong and slightly oval in shape. A delicate white waxy scale is their only protection. The mature male is a delicate two-winged insect, in general appearance resembling the males of the two preceding species. Under this delicate covering the male undergoes its transformations, finally, about the time the female becomes full grown, emerging as a mature insect.

About the middle of May or early in June the females are mature and egg laying begins. The eggs are oblong oval in shape, pearly white and have smooth shells. They are laid under the mother shell, which is only the hardened integument of the parent insect, the mother scale herself literally turning into a mass of eggs. The number of eggs produced by a single scale varies greatly, probably from five or six hundred to over two thousand, the writer having counted over twenty-one hundred under a single female.

The newly hatched scales remain under the mother shells for a time varying from a few hours to two or three days. At this time they vary in size from 0.5 to 0.75 mm. in length and are a little more than half as broad as long. Their bodies are also very thin and slightly curved above.

As would be supposed, a swarm of little scales is produced from a single mother. After leaving the mother shell they travel about apparently aimlessly for a time, but within a few days settle down, most of them upon the under surface of the leaves along the midribs and larger veins, although many may be found upon the upper surface as well. Still others, however, may be found scat-

tered about promiscuously on both surfaces of the leaves, and it is not unusual to find some that have remained behind on the new and tender twigs. When attacking the leaves of the quince, they seem to prefer the upper surface, for out of a large number of quince leaves examined only an occasional scale could be found on the under surfaces, while the upper surfaces were moderately infested. It should be remembered that these young scales are very small at this time, and as they closely resemble the leaf in color and are almost semi-transparent, they are easily overlooked. Hence in examining the leaves for them it is well to use a small magnifying glass.

The scales grow slowly during the summer and gradually change to a dark, reddish brown color. During all of this time, however, they suck the sap vigorously and secrete much honey dew, causing the leaves, branches and fruit to become sticky and unsightly.

During the latter part of August or early in September the young scales migrate to the twigs and branches and even the trunk to seek shelter for the winter. On badly infested trees they may frequently be found overlapping one another and in sheltered places, as in crevices in the bark, it is not unusual to find them two or three deep. In this condition they remain until spring, when activity is again renewed and the life cycle completed.

Means of distribution.—The hibernating scales are easily carried about on nursery stock. Young nursery trees probably seldom become badly infested. All of the infested trees which we have seen had but comparatively few scales on them and these were scattered about on the trunks and branches and were usually hidden in scars on the trunks and near the buds so effectually that they were easily overlooked. Thus the young scales, although not protected by a scaly covering, are not easily rubbed off and hence may remain on trees shipped long distances without injury.

Remedial measures.—In the report above referred to we have given a detailed account of a series of experiments with kerosene emulsion as a remedy for this species. It was found that kero-

sene emulsion, diluted with from four to six parts of water, could be depended upon to kill the hibernating scales when applied to the infested trees in the form of a spray. When the spray is to be directed against the newly hatched lice, the emulsion should not be diluted with more than nine parts of water.

THE OAK SCALE.

Asterodiaspis quercicola Bouché.

There are but few references to this insect in the writings of American entomologists. In his report for 1880, p. 330, Prof. J. H. Comstock, who was then Entomologist of the United States Department of Agriculture, published a description of the male and female, the former being taken from Signoret. Another reference is in Insect Life, Vol. II, p. 41, in which Dr. L. O. Howard states that this scale is found almost solely upon American oaks in a grove in the Department grounds, previously referred to by Professor Comstock in his report for 1880. In Insect Life, Vol. VII, p. 120, Mr. C. L. Marlatt gives the result of experiments against this insect. He found that the newly hatched young could be killed by spraying the infested trees with kerosene emulsion, one part to thirteen parts of water. In the same volume, page 428, a brief reference is made to a note by Mr. R. Newstead in the Entomologist's Monthly Magazine for April, 1895, in which he states that, although birds are not usually supposed to feed on scale insects, he had found that the blue tit and longtailed tit feed on this and certain other species.

It is probable that, except in isolated cases, the species has never been a serious pest in this country.

As its name implies, this scale attacks the oak. Some idea of its general appearance can be had by referring to Plate XIX, fig. 6. This figure is from a photograph of an infested twig, natural size. The female scales are nearly circular and somewhat conical. They are dark or yellowish green in color. When one of the mature scales is removed, it will be found to have made a pit-like depression in the bark. The mature female scales will measure from 1 mm. to nearly 2 mm. in diameter. According to Sig-

noret, as quoted by Comstock, the male scales are oval and usually smaller than the females, measuring but 1 mm. in length. But little is known of the life history of this species.

We have seldom found this scale in the nursery. It may do serious injury on large trees, however. A good illustration of this is on one of the principal streets of Geneva, where most of the English oaks, *Quercus robar*, which line the streets for two or three blocks on either side, have been either killed or nearly so by this scale. So far as we know its only food plant is the oak.

THE SAN JOSÉ SCALE.

Aspidiotus perniciosus Comst.

At present this is the most important of all the species of insects which attack nursery stock. It is important, not only because of the injury to the trees which it is capable of doing, but because nurserymen and fruitgrowers are afraid of it, and hence hesitate to buy stock from a nursery in a locality where the scale is known to exist. It is also of especial interest to nurserymen and fruit growers in this State because it is being found each season in new localities within our borders. The finding of the scale in a small nursery near Union Springs probably means that it has been sent to numerous localities within the State. Much has been written about it and it has been described and its life history written over and over again. Yet a very large majority of the nurserymen and fruit growers of the State seem to have but little idea of the true nature of the insect. It may be well, therefore, to give a somewhat detailed account of it in these pages.

History.—The original home of the San José scale is not positively known. Some writers think that it originally came from South America while others believe that its native home may have been Japan or possibly Australia. But wherever its original home may have been it is said to have been known in the San José Valley, California, as early as 1870. In 1880 Prof. J. H. Comstock described it and gave it its scientific name. It was not discovered in the east until 1893 when a few trees in an

orchard at Charlottesville, Va., were found infested. Subsequent investigations showed that these trees came originally from a New Jersey nursery. In 1894 the scale was found on Long Island and other points in this State.

Present distribution.—According to Messrs. Howard and Marlatt* the scale was known in 1896 in Alabama, Arizona, California, Delaware, Florida, Georgia, Idaho, Indiana, Louisiana, Massachusetts, Maryland, New Jersey, New York, New Mexico, Ohio, Oregon, Pennsylvania, Virginia, Washington, West Virginia and British Columbia. In addition to the above states it is now known to occur in several localities in Michigan and in the provinces of Canada. In this State it has been found in the following counties: Suffolk, in several orchards; Queens, in three nurseries; Kings, in one small orchard near Brooklyn; Orange, in an orchard at New Milford (Dr. Lintner); Dutchess, in an orchard near Poughkeepsie; Columbia, in an orchard near Germantown and two at Kinderhook; Tompkins, on ornamentals on the campus of Cornell University; Seneca, two trees, which have been burned, in an orchard near Farmer; Cayuga, in an old nursery near Union Springs.

Food plants.—The following list of food plants, which includes those observed up to 1896, is given by Dr. J. B. Smith.† It will be of especial interest to nurserymen and hence is given here in full. Linden, enonymus, almond, peach, apricot, plum, cherry, locust, spiræa, raspberry, blackberry, rose, hawthorne, cotoneaster, pear, apple, quince, flowering quince, gooseberry, currant, flowering currant, persimmon, acacia, elm, osage orange, English walnut, pecan, hickory, alder, chestnut, oak, birch, weeping willow, laurel leaved willow, Kilmarnock willow, sumach and grape. A list published in July, 1897, by Prof. F. M. Webster‡ includes black walnut, Carolina poplar, lombardy poplar, golden leaf poplar, European willow, cut leaf birch, flowering peach, flowering cherry, American linden, European linden, hardy catalpa and mountain ash in addition to those given above.

*U. S. Dept. Agr. Div. Ent. Bul. 3, new series.
†N. J. Agl. Exp. Stas. Rept. 1896, p. 547.
‡Ohio Agl. Exp. Sta. Bul. 81, p. 184.

From the above lists it will be seen that the scale may be found on practically all classes of nursery stock grown in the east. It is not known to attack citrus fruits.

Descriptions and life history.—A good idea of the general appearance of the scale is given in Plate XXI, figs. 1 to 4. Here the scales are shown natural size and enlarged on both twigs and fruit. The female scales are greatly in excess of the males, which is the case with most other scale insects. The following description is taken from Bul. 3 (new series), U. S. Department of Agriculture Division of Entomology, by Howard and Marlatt, p. 46: "The scale of the female is circular, very slightly raised centrally, and varies in diameter from 1 to 2 mm., averaging about 1.4 mm. The exuviæ is central or nearly so. The large well-developed scales are gray, excepting the central part covering the exuviæ, which varies from pale to reddish yellow, although in some cases dark colored. The scale is usually smooth exteriorly or sometimes slightly annulated, and the limits of the larval scale are always plainly marked. The natural color of the scale is frequently obscured by the presence of the sooty fungus [*Fumago salicina*].

The microscopic characteristics of the mature female are shown at Plate XX, fig. 2. At *b* the ornamentation of the anal plate is shown. This is of especial value in determining the species. Those who wish to make microscopical examination of the insect to determine the species, will find that the characteristics of the anal plate can be brought out by boiling the insect for a few minutes in a weak solution of caustic potash, then washing, then, after placing in alcohol for a short time, cleaning in oil of cloves or other convenient cleaning solution. The specimen should then be mounted in balsam. The *male scale* is darker than the female scale, "oblong oval" in shape, "nearly twice as long as wide and about half the diameter of the female scale." (Howard and Marlatt.) The mature male is a delicate two winged insect, orange yellow in color excepting the head, which is somewhat darker.

The main points of the insect's life history may be briefly stated as follows: In this climate, if an infested tree is ex-

amined during the winter the scales will be found varying in size from less than half grown to fully matured. On badly infested trees they are crowded in great numbers very close together. On trees not badly infested they will be found in groups of from two or three to many more with numerous individuals scattered about on the bark. The writer has not had an opportunity of studying the life history of the scale in western New York until within the past few weeks, and hence no observations have been made as to the time the females first begin producing young in the spring. On Long Island, however, the males mature in April and during the following month the females begin giving birth to young. Unlike most scale insects, the young are brought forth, in nearly all cases, alive. According to Howard and Marlatt the average number of young produced by a single female is 400. The period during which an individual female will continue producing young lasts for six or seven weeks. The newly born scales are nearly microscopic in size, with bodies oval in shape, when viewed from above, and orange yellow in color. They remain under the mother scale for a short time, finally coming forth to wander about until a suitable place is found to insert their sharp thread-like setæ by means of which they suck the sap. By this time thread-like waxy secretions have begun to appear on the back of each little scale. These waxy secretions together with the cast skins form the scales. At first there is no difference in appearance between the male and female scales, but according to Howard and Marlatt* the difference becomes apparent after the first molt. Owing to the comparatively long period during which young are produced it is difficult to ascertain the number of generations. Judging from the scales, as they appear in the winter, however, it is probable that young are produced until the latter part of the summer or early in the fall. After all their young have been brought forth the old females die, the young surviving to continue the species.

Means of distribution.—Locally the active scales are undoubtedly carried about by birds; insects, such as beetles; and probably on the clothing of persons working in the infested nursery

*U. S. Dept. Agr. Div. Ent. Bul. 3, new series, p. 46.

or orchard. An illustration of this was noticed in one of the nurseries previously referred to. In this nursery it is evident that the scales were first introduced on a few trees. These are very badly infested, those in their immediate vicinity less so and those four or five rods away still less. Along the road bordering this nursery and about forty rods away are a dozen or more pear trees which have been in bearing about two years. These are healthy, vigorous trees and are only very slightly infested having evidently become infested only within the past year. It seems very probable that the only way the scales could have been brought to these trees was by some of the means above referred to.

It is undoubtedly safe to say that the scale is sent broadcast over the country by means of nursery stock more than in any other way. It is true that infested pears from California have frequently been found on fruit stands in some of our eastern cities, but there is very much less chance of spreading the scale in this way than by infested nursery stock. Infested trees dug either in the fall or spring will carry dormant scales.

Remedial measures.—Various insecticides have been tested in the east against this insect. Eight of the most important of these are discussed in Bulletin No. 87 of this Station. The insecticide which has proved the most successful in the east is whale oil soap. This should be applied at least twice to the infested trees in the fall after the leaves have fallen, at a strength of two pounds to a gallon of water. Another application should be made in the spring before the buds begin to swell. A portion of an infested plum orchard which was carefully sprayed with whale oil soap at this strength was practically freed from the scale after two applications. It is important to have good whale oil soap. That manufactured by Leggett Bros., 301 Pearl Street, New York, and by James Good, 514-518 Hurst Street, Philadelphia, is highly recommended. Dr. J. B. Smith* recommends a fish oil soap, which can be made after the following formula:

Concentrated lye	3½ pounds.
Water	7½ gallons.
Fish oil	1 gallon.

*N. J. Agr. Exp. Stas. Rept. 1896, p. 559.

The lye should be dissolved in boiling water and the fish oil at once added. This mixture should be kept boiling for two hours and then allowed to cool. This soap should be used at a strength of one pound to one gallon of water.

Pure kerosene oil has been used as a winter application with varying degrees of success. It will kill all the scales with which it comes in contact, but unless the tree is very hardy or the conditions are just right it is liable to kill the tree also. It should not be used except in extreme cases.

When the trees or nursery stock are to be fumigated with hydocyanic acid gas, the gas may be generated after the following formula:

Fused cyanide of potassium (98 per cent)	1 oz.
Sulphuric acid, commercial	1 oz.
Water	3 ozs.

Pour the water and the sulphuric acid into a glass or glazed earthenware dish. When this is placed where it is to remain add the cyanide of potassium. This will generate enough gas for 150 cubic feet of space. Much care should be taken that the operator does not breathe any of the fumes.

Fumigation is not considered the most practical method of treatment for infested orchard trees here in the east, but it may be used for infested nursery stock. On another page reference is made to treating nursery stock in large cellars. A convenient house for fumigating a small amount of nursery stock is shown at Plate XXII. These may be built any convenient size. They are built of a double thickness of boards with building paper between to make them as nearly air tight as can be conveniently done. The door is made to fit very tight. The stock is piled in the house in such a manner as to allow the gas to circulate freely. One generator with enough material to fill the space is placed about the middle of the floor and as soon as the cyanide is added, the door is shut and the stock left for an hour. When the fumigating is done on a cool, cloudy day or at night, there is practically no danger of injuring the stock as shown by the fact that various varieties of fruit trees, also currants and gooseberries,

have been exposed in the building shown in the plate and in others in their immediate vicinity, all night without the least apparent injury.

A closely allied species common in New York.—This insect, *Aspidiotus ancylus* Putn., resembles the San José scale in general appearance and is frequently mistaken for it. It is not a serious pest in this State, however, but in the south it may occur in sufficient numbers to do serious injury to the infested plants. Its life history has not been worked out for this locality.

We have frequently found this species in the nursery, usually on young plum trees, but in no instance were the scales in sufficient numbers to injure the trees to an appreciable extent.

According to Prof. T. D. A. Cockerell* this scale is found upon ash, maple, beech, linden, oak, osage orange, peach, hackberry, bladder nut and water locust.

PLANT LICE.

The nature of these insects in general need not be enlarged upon here as the principal prints in their development will be touched upon in another bulletin. These insects were unusually abundant last year in both nurseries and orchards. One of the species, *Hyalopterus pruni*, which was abundant on the plum last season is shown at Plate XXIV, fig. 5. This species was also very abundant in some of the nurseries examined last season but will be discussed more in detail in the bulletin above referred to.

THE WOOLLY LOUSE OF THE APPLE.

Schizeneura lanigera Hausm.

The writer has found this species more common in New York nurseries than any of the other injurious insects. As a rule apple trees were the worst infested, but blocks of pears or quince trees growing next to blocks of infested apples, were also usually infested.

The life history and habits of this insect together with its importance as a nursery stock pest are discussed by the writer in the Annual Report of the Station for 1896, pages 570-577, and hence it will be unnecessary to discuss these points in detail here.

*U. S. Dept. Agr. Div. Ent. Bul. No. 6, technical series, p. 20.

It may be stated, however, that in some sections of the State this species of woolly aphis is doing very serious injury every year both in the nurseries and young orchards. The insect and its work are illustrated at Plate XXIII, figs. 1 to 5. All of the photographs for this plate were made from an infested apple tree taken from a nursery at Geneva. The insect works on both roots and branches. Those infesting the former are referred to as the root inhabiting form and those on the branches as the aerial form. The injury to the roots caused by the lice is shown at Fig. 3. The larger roots are more or less deformed and are covered with galls. A nearer view of some of the galls is shown at Fig. 4. Fig. 1 shows the appearance of a badly infested twig. The lice collect on the under sides of the limbs and twigs and secrete a bluish white cottony substance which completely covers them. If these lice are removed it will be found that they have formed numerous galls and pits on the bark. At Fig. 2 one of these galls and some of the lice, with most of the cottony substance removed, are shown enlarged to about four times natural size.

The lice are distributed in the nursery or orchard by means of the migrating females, but they are distributed over the country by means of infested nursery stock. Many trees with infested roots are shipped, but the lice are frequently found in the scars along the trunks of the young trees as shown at Fig. 5. The lice hibernate in these scars and other similar places on the trees. The winter eggs may also be frequently found among these hibernating lice. In a large majority of cases the infested trees found on the packing grounds during the past two seasons by the writer, were harboring the lice in these scars on the trunks only, very few of them having infested roots. It is important that nurserymen and buyers take pains to avoid selling or planting stock thus infested. The lice can be easily and quickly killed by touching these infested scars with a cloth saturated with kerosene oil.

This insect is widely distributed throughout the United States and is well known in Europe. It is probably found in this State

wherever apples are grown. Our records show that it has been either observed by the writer in injurious numbers or reported to the Station from the following counties: Chautauqua, Monroe, Wayne, Ontario, Yates, Seneca, Cayuga, Columbia, Dutchess, Queens and Suffolk.

BORERS.

This group includes a number of the most serious pests in nursery and orchard trees. By "borers" is usually meant those insects which bore into the roots, trunks or branches of the infested plant. As the larvæ are most active in the injurious work the term refers especially to them. The only species of borer which was found doing serious injury in the nurseries is the peach tree borer.

THE PEACH TREE BORER.

Sannina exitiosa Say.

This insect is also discussed at length in the Annual Report of this Station for 1896, pp. 559-567, and hence need be only briefly mentioned here.

The nature of the insect is shown at Plate XXIV, figs. 1 to 3. The injury is done by the larvæ which bore into the trunk or roots, feeding largely on the sapwood. One of the larvæ is shown at Fig 1. At Fig. 2 the pupa (*a*) and male (*b*) and female (*c*) moths are shown. Both figures are from photographs showing the originals natural size. At Fig. 3 an upper and side view of one of the larvæ slightly enlarged is shown.

In some sections of the State this insect is usually very abundant. The borers were much less frequently found the past season than the season previous.

This insect has also a wide distribution and is well known in all parts of the State. We have found it especially abundant in Monroe, Wayne, Ontario, Seneca and Cayuga counties.

CASE-BEARING INSECTS.

Under this head may be included two species of insects which have done serious injury in the nurseries and orchards, especially the latter, in this State during the past two seasons. These are

commonly known as the pistol-case-bearer and the cigar-case-bearer. They are called case-bearers because the caterpillars construct cases for themselves which they carry on their backs and which serve as protection to the owners.

The Pistol-Case-Bearer.

Coleophora malivorella Riley.

This insect should receive the careful attention of both nurserymen and fruit growers as it is becoming a very serious pest. It is especially injurious to the apple and pear and is known to attack the quince. The principal injury is done to the buds and expanding leaves. The young caterpillars construct pistol-shaped cases soon after hatching. They hibernate in these and during the winter the cases may be seen attached to the twigs, as shown at Plate XXIV, fig. 4. The case-bearers are more noticeable during the spring or early summer as their cases are much larger and their injurious work more apparent. This insect is discussed in detail in Bulletin No. 122 of this Station.

The pistol-case-bearer is probably distributed over a considerable area in the eastern states. It is especially injurious in the apple orchards of western New York. The writer has observed it in seriously injurious numbers in some of the large orchards in Orleans, Monroe, Wayne, Ontario and Seneca counties.

Cigar-Case-Bearer.

Coleophora fletcherella Fernald.

A closely allied species is the cigar-case-bearer. The case of the mature caterpillar resembles a miniature cigar, hence the name. The writer has not observed this species in the nursery as frequently as the other, but it is well known as a serious pest in the apple orchards, especially in the western part of the State. The hibernating case-bearers of this species are not as easily detected as those of the other. Their cases are smaller, usually a little lighter colored and bent in the shape of a crescent moon. They are usually found close beside the winter buds or partially hidden in a fold in the bark or the angle made by a branching twig. It is as widely distributed as the former species and is found on the same food plants.

THE BUD MOTH.

Tmetocera ocellana Schif.

Although not a case-bearing insect the discussion of the species may be placed here for convenience.

History.—This species is probably of European origin. It was known as a serious pest in this country nearly fifty years ago. Since then it has been recorded as a serious pest in various parts of the eastern states.

Present distribution.—It is probably well distributed throughout the eastern states. It is also well known in Canada. It has been found in Missouri and as far west as Idaho.

Food plants.—The writer has observed this insect upon apple, pear, plum and peach trees. According to Prof. M. V. Slingerland,* who has made a careful study of this species, it also attacks the cherry, quince and blackberry.

Descriptions and life history.—The life history of this insect has not been studied out by the writer. As given by Prof. Slingerland, in the bulletin above referred to it is briefly, as follows: Usually the nurseryman or fruit grower is not aware that this insect is injuring his trees until he finds that many of the leaf buds fail to produce leaves in the spring. Upon examination the little brown caterpillars may be found eating out the tender centers of the swelling buds. Later in the season they attack the unfolding leaves, drawing them together with silken threads as shown at Plate XXIV, fig. 6. By June the caterpillars are full grown. The pupa stage is passed in these nests, "in a tube of dead leaves," and lasts about ten days. The parent insects are dark ash gray moths marked with a cream white band across the front wings. In three or four days after emerging the moths lay their eggs. The eggs resemble minute drops of water and are laid singly or in clusters on the leaves. The eggs hatch in from seven to ten days. The young caterpillars soon begin to feed on the skin of the leaf. They also make for themselves tubes of silk usually along the midrib of the leaf. They continue to feed during July and part of August, devouring only the soft parts of the

*Cornell Univ. Agl. Exp. Sta. Bul. 107, p. 67.

leaf. During August the caterpillars migrate to the twigs where they spin silken cases on which to pass the winter. These cases are about one-eighth of an inch long, and as they lie close to the bark and resemble it in color are not readily detected.

The writer has quite frequently found these cases with their hibernating caterpillars on nursery trees about to be shipped from the packing grounds. It is in this manner that the insect is most readily distributed over the country.

Remedial measures.—Where practicable the trees should be thoroughly sprayed with Paris green, 1 pound to 150 gallons of water, before the buds open in the spring. Two applications will be found better than one, the object being to keep the buds coated with the poison so that the first meal of the caterpillars in the spring will be a poisoned one. Experiments at this Station have shown that the bud moth can be held in check in this way.

In nurseries and in orchards, also, serious injury may be prevented by cutting out the nests which are rendered conspicuous by the partially dead leaves. This should be done before the moths come forth, thus reducing the numbers of the next brood.

EXPERIMENTS IN TREATING INFESTED NURSERY STOCK.

Dipping Young Stock Infested with Plant Lice.

As noted on a previous page, plant lice have been unusually abundant during the past season. Their injurious work has been especially evident in the nurseries. The greatest injury was usually caused to seedling and one-year-old fruit trees. The lice attacked the tender leaves at the tips of the young trees soon causing them to curl so badly that the insects could not be reached with a spray. In the nursery in which the experiments were made the infested trees, principally sweet cherry, apple and pear trees, showed serious injury from the effects of the lice. The experiments were undertaken with a view to determining a practical method of checking the injurious work of the lice. It

was evident that spraying would not be a success and so dipping the infested trees in a solution of whale oil soap and water was resorted to. It might at first seem that this method would be impractical because of the time and labor involved, but it should be remembered that the lice appear on comparatively few trees first, others becoming infested from these later in the season, and hence if they are successfully treated more serious injury by the lice may be prevented.

All of the trees used in the experiments were seedlings, one-year-olds and two-year-olds. As the lice were congregated on the leaves at the tips it was necessary to wet only this portion of the tree. The dipping of the stock was found to be a very simple matter. Three or four men carrying pails filled with the solution passed through the blocks and, picking out the infested trees, bent them over carefully and dipped their tips into the solution, taking care to hold them long enough to wet all of the lice. It was found unnecessary to spend more than two minutes to a tree.

Experiments.—About a thousand trees were used in experiments, which for convenience may be divided into six blocks. Blocks I and II were sweet cherries badly infested with the black cherry aphis, *Myzus cerasi.* Blocks III and IV were apples also badly infested, but with the apple aphis, *Aphis mali.* Blocks V and VI were standard pears infested with a species of plant lice, *Aphis* sp. Blocks I, III and V were treated the same day, a bright, warm day about the middle of July, with a solution of whale oil soap, 1 pound to 3 gallons of water. Blocks II, IV and VI were treated within two days of this time, under practically the same weather conditions, with a solution of whale oil soap, 1 pound to 7 gallons of water. But one application was made in each case.

Results.—In nearly every case where the stronger soap solution, 1 pound to 3 gallons, was used, the leaves were more or less injured. The pears were injured most while there was not much difference between the apples and cherries. So far as could be ascertained, all of the lice on these trees were killed. The weaker solution, 1 pound to 7 gallons, did not injure the foliage in any

instance, but proved fully as effectual as the stronger solution in killing the lice. These treated trees were not seriously infested again during the season.

Conclusions.—The above experiments indicate that, when young nursery trees become so badly infested with plant lice as to make spraying impractical, they may be successfully treated by dipping the curled tips in a solution of whale-oil soap, one pound to seven gallons of water. The expense and labor were so slight as to be factors of but little importance. When thoroughly done but one treatment is necessary under ordinary circumstances.

SPRAYING YOUNG GRAFTS.

Most of these experiments were conducted against a large species of flea-beetle, *Systena hudsonias* Forst. The beetles were very abundant during June and July on apple and pear grafts in a nursery near the Station. The beetles fed voraciously on both upper and under surfaces of the leaves, eating away the tender tissue and causing them to wither and die. About twenty-five per cent of the grafts were killed before the experiments were commenced, and a whole block of 20,000 apple grafts was seriously threatened. The beetles were also doing serious injury in a small block of two-year-old apples and a large block of two-year-old pears in the same nursery. Green arsenite was used in all the experiments, and in each case sufficient lime was used to make the mixture "milky" in appearance. A barrel and pump, mounted on a small stone boat which could be easily hauled between the rows by one horse, was used. To each lead of hose a Y was attached so as to support two short lengths of hose. Two men followed the pump, spraying two rows at a time, thus requiring three men to do the work. Improved Vermorel nozzles were used.

Experiments.—Block 1; one-year-old apple grafts sprayed June 16, with green arsenite, 1 pound to 150 gallons of water. June 18 this block was again sprayed, but the poison was used at a strength of one pound to 100 gallons of water. June 25 a third application was made, the poison being used at the same strength.

Block II; two-year-old apple trees sprayed June 18 and again June 25, with green arsenite, one pound to 100 gallons of water.

Block III; two-year-old pear trees sprayed June 18 and again June 25 with green arsenite as in Block II.

Block IV; one-year-old apple grafts badly infested with canker worms. This block was sprayed early in June with the green arsenite, one pound to 100 gallons of water. A second application of the poison was unnecessary.

Results.—The green arsenite at one pound to 150 gallons of water had but little effect on the beetles. Where the stronger mixture was applied the effect was very apparent, after the second application. But few live beetles could be found, and after the third application no further injury to the stock was noticed. Although most of the spraying was done on a bright warm day, the most tender leaves did not show the slightest indications of having been burned by the green arsenite.

Block IV was freed from canker worms by one application of the poison at the strength stated.

Conclusions.—While these experiments should be carried further before final conclusions are reached, the results indicate that young grafts may be safely sprayed with the green arsenite, one pound to 100 gallons of water, provided enough lime is added to give the mixture a "milky" appearance. It may be here stated that it is important to add the lime as it not only makes the mixture spread and adhere to the leaf better, but prevents burning the foliage.

SPRAYING CUT-LEAVED BIRCH.

These trees constituted a small block in one of the Geneva nurseries. Nearly all of the trees were badly infested with thrips [*Thrips* sp.] These are very small, almost microscopic insects, which feed on the soft parts of the leaves, soon causing them to wither and die. They are frequently very injurious, and are well known to both gardeners and fruit growers. They are hard to reach with insecticides, as they fly away as soon as disturbed by the spray mixture. The trees in question were beginning to show the injury which the insects were causing before the spraying was

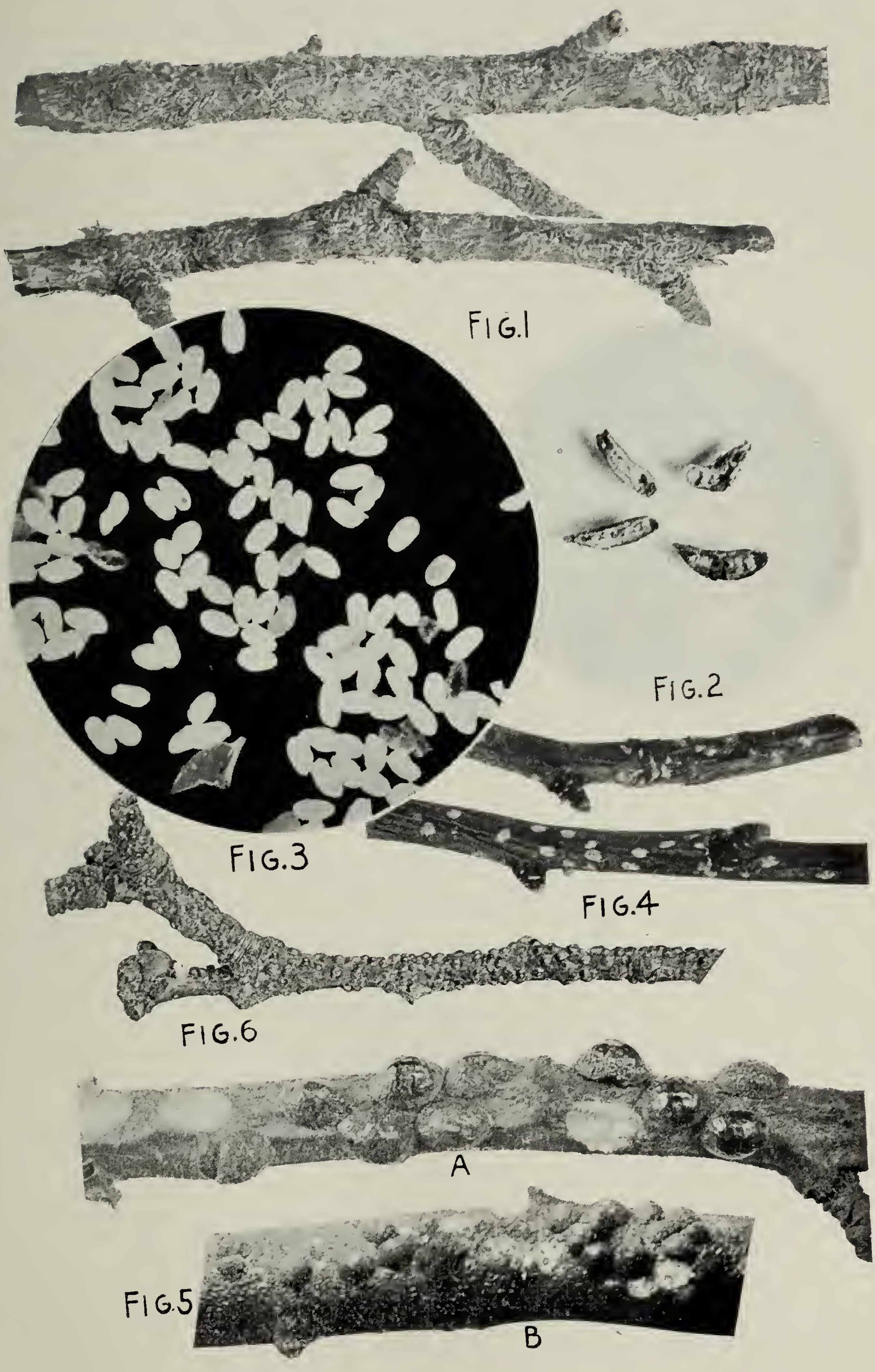


PLATE XIX.

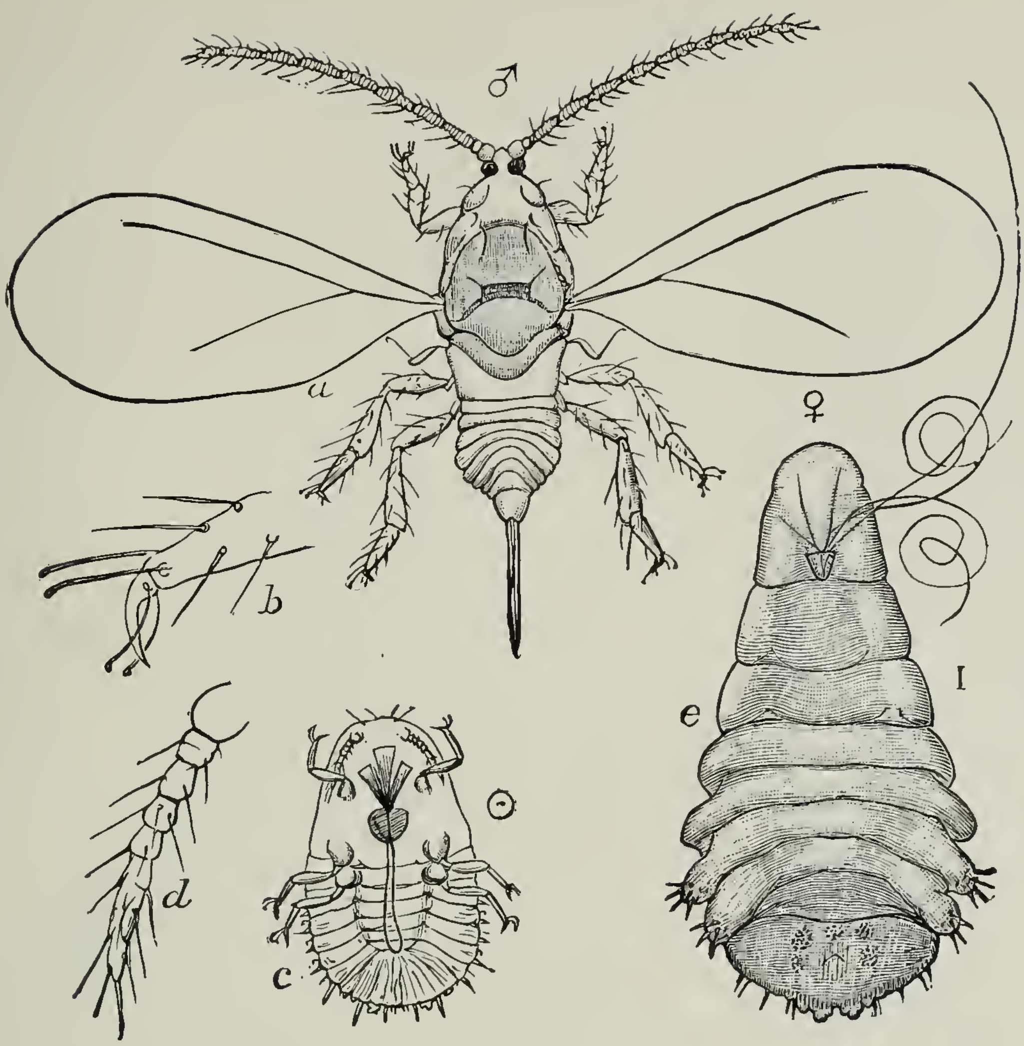


PLATE XX. FIG. 1.

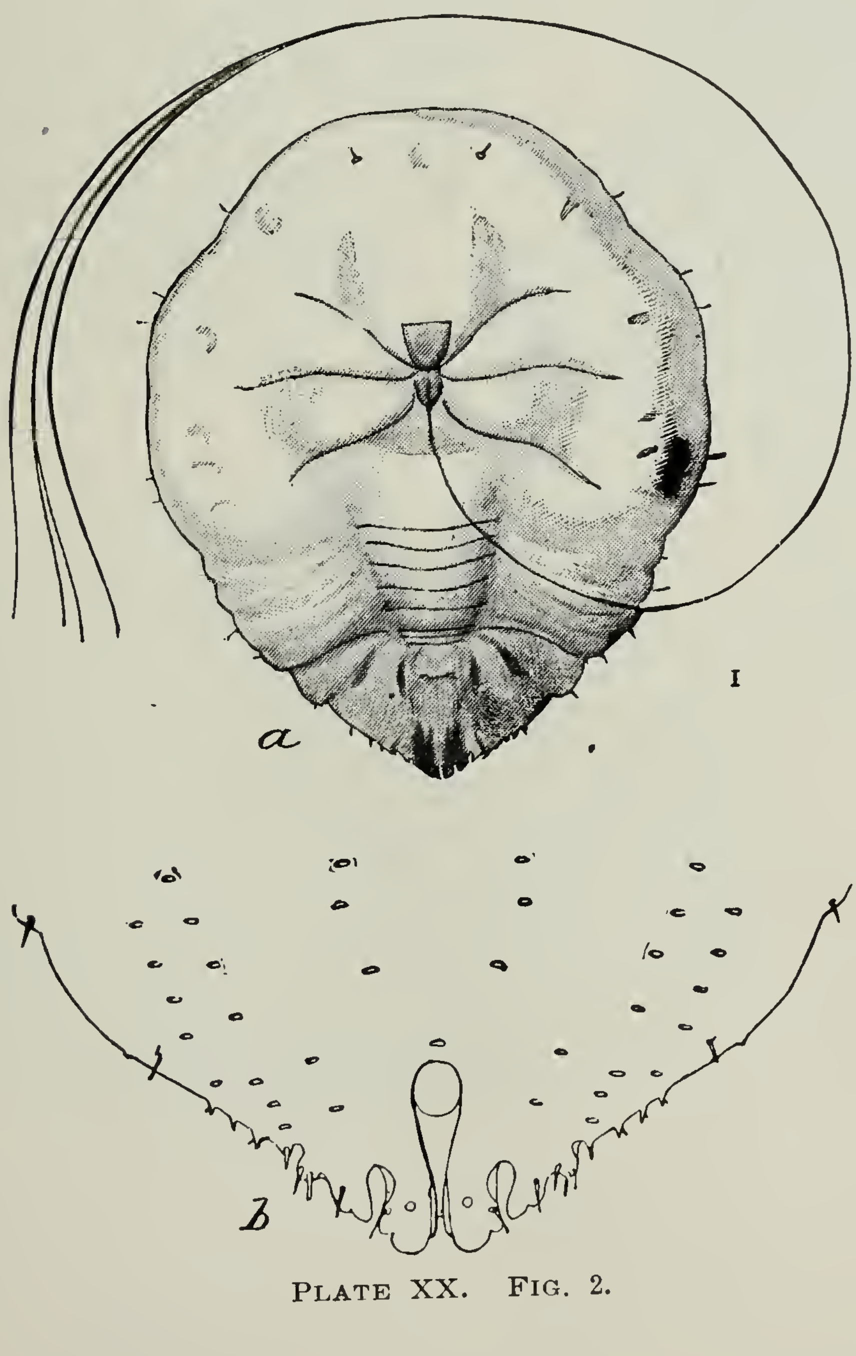


PLATE XX. FIG. 2.

FIG 1

FIG. 3

FIG. 4

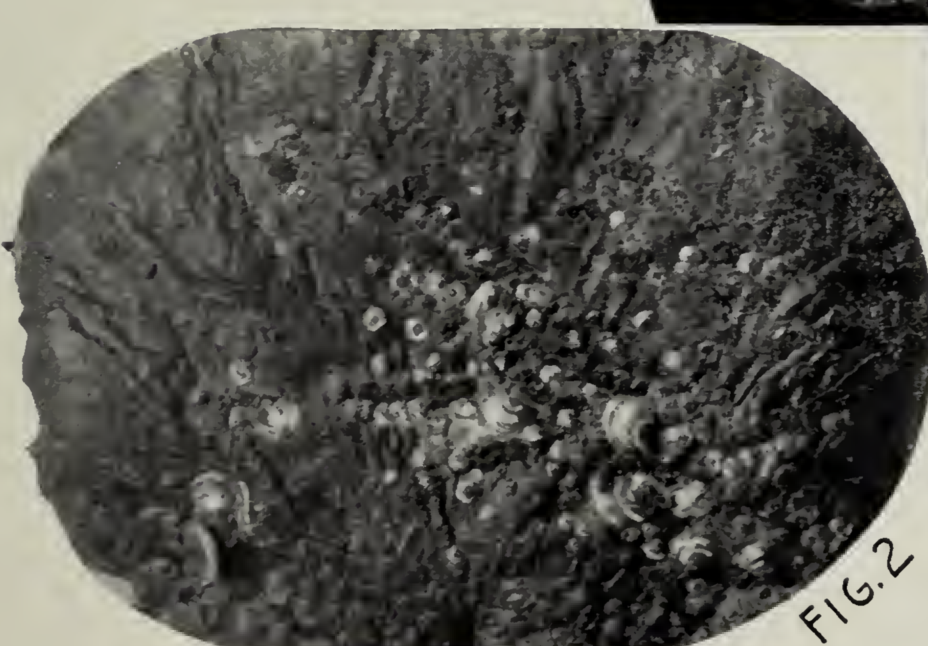


FIG. 2

PLATE XXI.

done. In all cases much pains was taken to wet both upper and under surfaces of the leaves.

Experiments.—About the middle of June the block was sprayed with a solution of whale-oil soap, one pound to seven gallons of water. After waiting two days no beneficial results were apparent. The block was again sprayed with whale-oil soap, one pound to four gallons of water. This had the effect of keeping the insects away for a few days, but injured the foliage slightly during one or two warm bright days which followed the application of the soap. In about six days from this last application the trees were again sprayed, this time with whale-oil soap, one pound to seven gallons of water, with the addition of flowers of sulphur, one ounce to each gallon of solution. This proved much more effectual than either of the other applications. Another application of the soap solution with the sulphur added was made a week later. Although this species of thrips continued abundant throughout the season on other ornamentals in the immediate vicinity of the block of birch, no further injury of a serious nature resulted to the sprayed trees.

Conclusions.— These experiments indicate that thrips can be held in check by a whale-oil soap solution, one pound to seven gallons of water, with the addition of one ounce of flowers of sulphur to each gallon of the solution when attacking trees similar to the cut-leaved birch. It should be remembered that it is important that the leaves should be drenched on both upper and under surfaces.

Experiments in Fumigating Nursery Stock.

These experiments have only just begun, and hence require but brief mention here. Fumigating nursery stock is usually done for the purpose of killing the San José scale. If fumigation can be made practical in the large cellars used by nurserymen it will be an inexpensive way to treat a large amount of stock, and a preventive to the spread not only of the San José scale, but other insects, such as the woolly aphis, bud moth, pistol-case-bearer and other injurious species. Experiments along this line are being

conducted in the insectary at the Station and in one of the large frost proof cellars of the Chase Nursery Co., at Rochester. The cellar is 80 feet long, 40 feet wide and 16 feet high. This was filled with fruit trees of all varieties and fumigated with hydrocyanic acid gas. Before the gas was generated, twigs infested with the woolly aphis and the pistol-case-bearer were placed in different parts of the cellar including the remotest parts and under some of the piles of trees. The trees were exposed all night, fourteen hours. The temperature in the cellar was a little above freezing. The twigs were carefully examined and all of the lice were dead. The pistol-case-bearers are apparently dead, but are being kept in the insectary awaiting results when it becomes time for them to revive.

PLATE XXII.

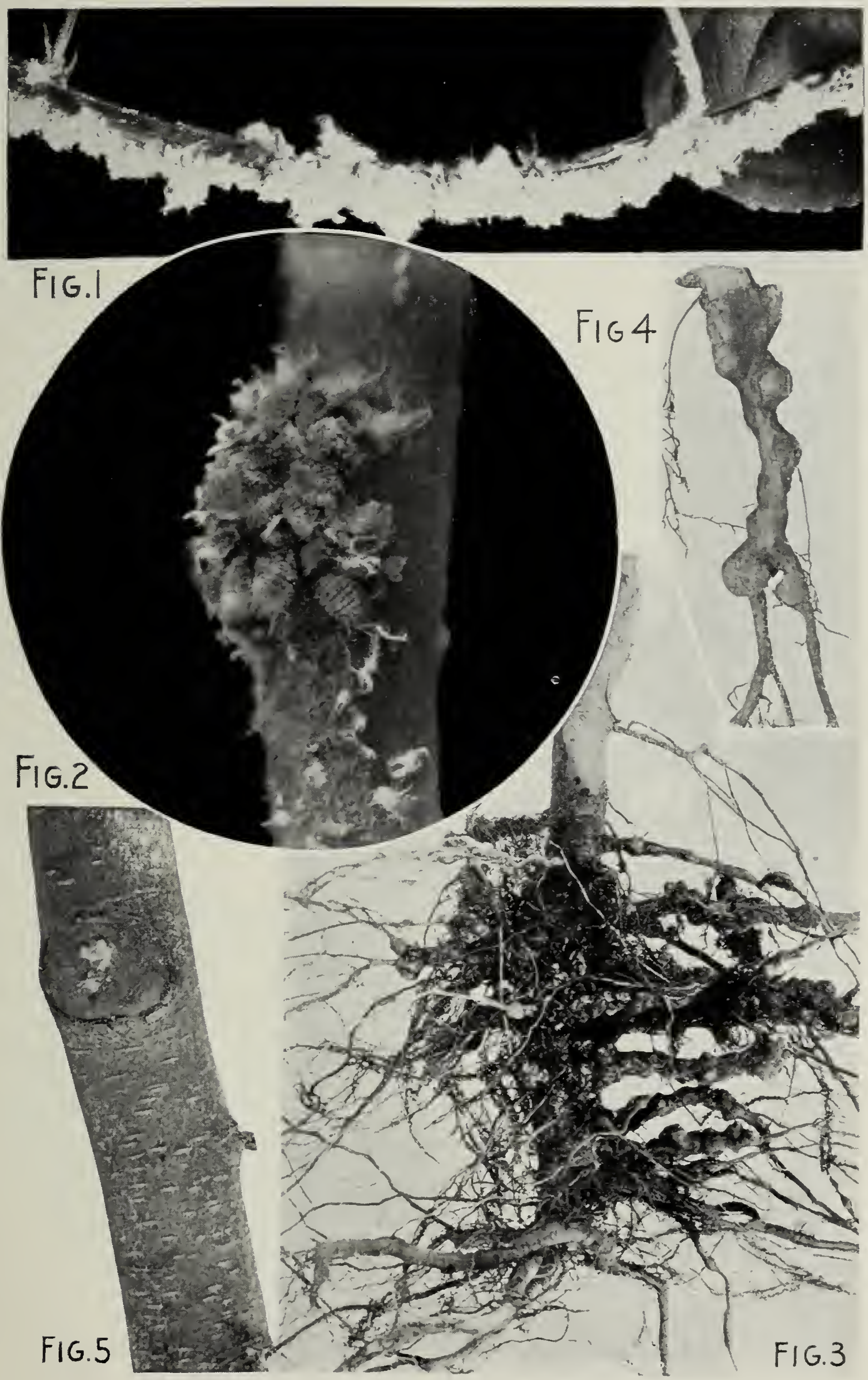


PLATE XXIII.

FIG. 1

FIG. 2

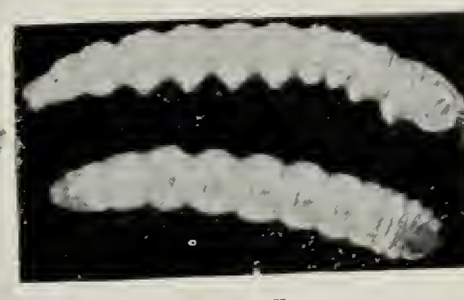


FIG 3

FIG. 4

FIG. 5

FIG. 6

PLATE XXIV.

EXPLANATION OF PLATES.

Plate XIX. Fig. 1, the oyster-shell bark-louse, natural size; 2, view of under surface of some of the scales showing eggs, enlarged; 3, photomicrograph of some of the eggs; 4, scurfy bark-louse, natural size; 5, plum lecanium, *a*, enlarged, *b*, natural size; 6, the oak scale, natural size.

Plate XX. Fig. 1, the oyster-shell bark-louse; *a*, adult male; *b*, foot of same; *c*, young larva; *d*, antenna of same; *e*, adult female taken from scale—*a*, *c*, *e*, greatly enlarged, *b*, *d*, still more enlarged.

Fig. 2. The San José scale, adult female before development of eggs; *a*, ventral view showing very long sucking setæ; *b*, anal plate, showing characteristic ornamentation of edge, greatly enlarged.

(L. O. Howard and C. L. Marlatt, United States Department of Agriculture, Division of Entomology.)

Plate XXI. The San José scale. Fig. 1, infested pear [Duchess d'Angoulême]; 2, portion of the pear enlarged, showing scales about four times natural size; 3, infested pear twig, natural size; 4, section of the same, enlarged.

Plate XXII. Small house for fumigating nursery stock.

Plate XXIII. The woolly louse of the apple. Fig. 1, infested apple twig, natural size; 2, section of the same twig enlarged, showing gall and lice; 3, roots of young apple, showing galls made by the lice; 4, some of the galls, natural size; 5, scar on trunk of young apple tree in which lice have congregated.

Plate XXIV. Fig. 1, plum root showing work of peach tree borer; 2, *a*, pupa case with chrysalis emerging; *b* and *c*, male and female moths; 3, larva, two views. [Fig. 2, natural size; Fig. 3, slightly enlarged. From photographs by Mr. F. A. Sirrine.] 4, pistol-case-bearers hibernating on apple twig, natural size; 5, plant lice, *Hyalopterus pruni*, on under surface of plum leaf, enlarged; 6, young apple leaves drawn together by larva of bud moth.

II. PLANT LICE: DESCRIPTIONS, ENEMIES AND TREATMENT.*

V. H. LOWE.

SUMMARY.

Plant lice are among the most important of the injurious insects. They may be found every year in the orchard and garden, but seldom in such numbers as during the past season.

Plant lice do not devour the tissue of the host plant, but suck the sap by means of their tube-like mouth parts. They swarm upon the open leaf-buds and on the under surfaces of the leaves, causing them to curl and to become otherwise distorted. These insects multiply with great rapidity, but are held in check to a certain degree by numerous predaceous and parasitic insects. In most species the young are born alive during the spring and summer, eggs not being produced until fall.

As plant lice suck their food, Paris green and similar poisons cannot be depended upon when used in the ordinary manner. Some external irritant must be used instead. Numerous insecticides of this nature are recommended. One of the most important is good whale-oil soap. Experiments during the past season show that one pound of whale oil soap to seven gallons of water will kill plum and currant lice. The solution should be applied in a fine spray to the under surface of the leaves. It is important that the work be done very thoroughly. The first application should be made as soon as the lice appear in the spring, which will be soon after the leaf-buds open. A second or third application may be made, as occasion demands.

*Reprint of Bulletin No. 139.

INTRODUCTION.

Plant lice are among the most important of the injurious insects. They infest all kinds of fruits, vegetables and ornamental plants. Although present every year, some seasons are more favorable for their development than others. The past season has been one of this kind, and various species of plant lice have caused serious injury throughout the State, especially to orchard and bush fruits. The large number of inquiries received at the Station asking for information concerning the nature and habits of these insects, together with the best-known methods of combating them, indicate the wide-spread injury caused by the lice and the need of information concerning them.

Plant lice are also among the most difficult insects to study. To work out all the details concerning the life history of any one species would, under ordinary circumstances, require more than a summer's work for a single individual. Observations on the species referred to in this bulletin were not begun, systematically, until last spring. The work is, therefore, necessarily incomplete; yet the existing circumstances are such that it seems best to publish a portion, at least, of the results thus far obtained.

PLANT LICE.

CLASSIFICATION.

Plant lice are true bugs. They belong to one of the largest and, from an economic standpoint, one of the most important orders of insects, namely, the *Hemiptera*. The mouth parts of insects of this group are modified into beak-like tubes, by means of which they suck their food. They are thus also classed with the suctorial feeders, as distinguished from those insects which masticate their food.

HOW PLANT LICE OBTAIN THEIR FOOD.

By carefully observing a plant louse when feeding, either from directly in front or from the side, it will be observed that the beak is extended so as to touch the surface of the leaf or is

thrust slightly into it. The beak incloses the thread-like mouth parts which the louse forces from the apex into the tissue, producing a wound which causes the sap to flow. This liquid food is pumped through the beak into the insect's body by means of suctorial muscles. Thus each plant louse is literally a minute pump, which robs the host plant of a portion of its sustenance.

NATURE OF THE INJURY CAUSED BY PLANT LICE.

Although all plant lice suck the sap of the host plant, the direct injury which they do may be manifest in different ways. Thus in some cases galls or pit-like depressions are formed on the parts attacked, as is the case with the woolly aphis, and certain species which produce galls on the leaves. Most species, however, which attack the leaves of cultivated fruits, cause them to curl, and, if the lice are very abundant, to wither and finally drop off.

An indirect injury caused by these insects is through the honey dew which they secrete. On badly infested trees the branches, leaves and fruit become coated with this sweet liquid, which, in the process of drying, becomes sticky. This sticky coating soon turns black, because of a black fungus which readily grows in it. Thus both the trees and fruit soon become unsightly, and, not infrequently, the latter is made unfit for market.

LIFE HISTORY.

As the life history of these interesting insects is not usually well understood by those not especially interested in the study of insects, it may be well to state briefly the main points in their development. The life history of different species varies, but the following will serve as a general illustration:

If a colony of plant lice is examined in the late spring or early summer it will be found to consist of winged and wingless females in all stages of development, from the newly born larvæ to the full grown individuals. The mature females give birth to living young with astonishing frequency. All of the young of these broods are females which mature

in an incredibly short time, giving birth, in turn, to female young at an equally rapid rate with their parents. Winged females are produced from time to time, apparently as occasion demands, for the dissemination of the species. These winged lice fly to other food plants or to other leaves on the same plant and start new colonies. This is continued during the summer. In many cases the lice migrate to new food plants for a portion of the summer. In the fall they may return to food plants of the same species as the original. These migratory broods consist of winged females. A generation of sexual forms, true males and females, is produced sometime during the fall. After pairing, each female produces one or more eggs. The eggs are usually placed on the twigs near the buds. They remain dormant all winter, hatching early in the spring into agamic females which, as they start the first broods of the season, are known as "stem mothers." It will be noticed that no male insects are produced throughout the season until fall. Reproduction is by a process known as budding. The following forms enter into the life cycle of a species during the season. The wingless and winged agamic female, the sexual female, the male, the winter egg and the "stem mother."

THE PRINCIPAL INSECTICIDES USED IN COMBATING PLANT-LICE.

These kill by contact. Internal poisons, such as Paris green and London purple, will not kill plant-lice when sprayed upon the leaves. The reason for this will be apparent when it is remembered that these insects suck the sap from beneath the surface of the leaf instead of devouring the leaf itself. The insecticides used for this purpose include kerosene emulsion, the kerosene-water mixture, whale-oil soap, tobacco in various forms, pyrethrum powder and hot water.

Kerosene emulsion.—This insecticide may be made after the following formula:

Water	1 gallon.
Soap, whale-oil soap preferred	½ pound.
Kerosene oil	2 gallons.

Dissolve the soap in the water by heating to the boiling point. When all the soap is dissolved remove from the fire and, while the solution is boiling hot, add the oil and agitate violently. This may be conveniently done by pumping the mixture through a small force pump. When sufficiently emulsified the mixture will have the appearance of milk. If allowed to cool it becomes thick like loppered milk. This is standard emulsion and may be diluted with water as desired. For ordinary use against such soft bodied insects as plant lice, 1 part of emulsion to from 10 to 15 parts of water is strong enough.

The kerosene-water mixture.—This is the simple mixture of kerosene and water without the use of soap or oil. The mixing is done in the pump and nozzles of the spraying outfits prepared especially for this purpose. The kerosene is held in one tank and the water in another. The pump draws from both tanks. The proportions of water and oil can be regulated at will.

The kerosene-water mixture has been used with good results against both plant-lice and scale insects. When applying the mixture to the foliage, care should be taken that injury to the tender leaves does not result from the separation of the oil and water.

Whale-oil or fish-oil soaps.—These soaps, when properly made, are among the most valuable of this class of insecticides. They may be made from any of the numerous fish oils on the market, but are usually sold under the name of whale-oil soap. The value of the soap as an insecticide lies, largely, in the caustic it contains.

Whale-oil soap was first used as an insecticide in this country nearly sixty years ago. It was recommended as a remedy for the rose bug and was used for this purpose at a strength of 1 lb. to 7½ gals. of water. The success which has attended its use against the San José scale in the east, has brought it into quite general use during the past few years. It now bids fair to take the place of kerosene emulsion.

One of the principal difficulties in the way of obtaining good results with the so called whale-oil soaps, is the fact that much of the soap of this nature sold on the market is of little or no value as an insecticide. Among the brands of whale-oil soap which have proven satisfactory in the hands of careful experimenters is that known as Good's Caustic Potash Whale Oil Soap No. 3, manufactured by James Good, 514-518 Hurst Street, Philadelphia, Pa. Also Leggett and Brother's Anchor Brand whale oil soap, manufactured by Leggett and Brother, 301 Pearl Street, New York. The price of strictly first class whale-oil soap varies from 3½ to 4 cents per pound in wholesale quantities.

It is sometimes desirable to make the soap at home. According to Lodeman* a good fish-oil soap may be made after the following formula:

Crystal potash lye	1 pound.
Fish oil	3 pints.
Soft water	3 gallons.

"Dissolve the lye in the water, and when boiling add the oil and boil for two hours."

Tobacco.—As an insecticide tobacco has a wide range of usefulness. It may be used dry or in the form of a decoction. If used dry it should be finely powdered, the finer the better. Tobacco decoction may be made after the following formula:

Refuse tobacco	1 pound.
Water	2 to 3 gallons.

The mixture should boil for thirty minutes or more, or until a dark brown tea results. It should be kept covered until cool and may be sprayed, undiluted, upon the infested plants.

Concentrated extract of tobacco.—There are several preparations of this nature now on the market each of which is sold under a different name. A brand called "Nikoteen," manufactured by the Skabcura Dip Co., Ninety-ninth Street and Torrence Avenue, Chicago, Ill., has been used at the Station with excellent results. This insecticide may be used either in the form of a vapor or as a spray. For use in the latter form against plant lice, 1 part nikoteen to 600 parts water is recommended.

*Spraying of Plants, p. 146.

Pyrethrum.—This is sold under the name of "Persian insect powder" or "buhach." It is a valuable insecticide and is especially adapted for use against plant lice and similar insects. It is one of the most powerful contact poisons and may be applied pure or mixed with two or three times its own bulk or diluent. When used in this way it is especially adapted to small conservatories.

Pyrethrum has also been used with kerosene emulsion either as a kerosene extract or mixed directly with the emulsion.

Hot water has been successfully used against plant lice. Its use is considered practical only on a small scale. Most plants will not be injured by the application of water heated to 130° F. This treatment is fatal to the lice. Where practical, the whole plant may be dipped.

EXPERIMENTS AGAINST PLANT LICE.

SPRAYING EXPERIMENTS WITH WHALE-OIL SOAP.

These experiments were conducted in the Station plum orchard and in the garden on red currant bushes. The principal object of the experiments was to demonstrate whether whale-oil soap could be depended upon to check plant-lice when used as a spray, and thus avoid the necessity of preparing kerosene emulsion. Both the plum trees and currant bushes were badly infested, the former principally with *Hyalopterus pruni* and the latter with *Myzus ribis*. Both of these species are treated in detail on subsequent pages. The currants were sprayed first as follows:

On May 15, with a solution of whale-oil soap, 1 pound to 10 gallons of water. Although much pains was taken to apply the spray so as to reach all of the lice, there was but little noticeable effect from the application.

On May 30 the currants were again sprayed but with a stronger solution of soap, 1 pound to 7 gallons of water. The leaves were badly curled, but by drenching them with the spray directed from below most of the lice were reached. The effects of this application were soon apparent.

Plate XXV.—Work of Plant Lice on Currants.

During the first week of June the bushes were sprayed again with the same solution of whale-oil soap, with the effect that they were practically freed from the insects.

Had the first solution been stronger, two applications would probably have been sufficient. Two rows were left unsprayed with the result shown at Plate XXV. At the time the photograph was taken, in early June, but few leaves were left on the bushes as a result of the work of the lice. The treated rows showed much less injury from the insects.

The plum trees were not sprayed until June 4. They were badly infested at this time, and the young leaves were so badly curled as to make it very difficult to reach all of the lice. The whale-oil soap solution, 1 pound to 7 gallons of water, was used on all of the trees. The effects of this treatment were at once apparent. Practically all the lice were killed on the leaves which were not so badly curled as to prevent the spray from reaching the insects.

Before the trees were sprayed a second time, about a week later, some of the worst infested trees were trimmed. The tips of the branches having the most curled leaves were cut off. This removed large numbers of lice and left but little refuge for those that remained. The trees were again sprayed with the whale-oil soap solution, as in the first instance, immediately after being trimmed, with the result that, in a short time, but comparatively few live lice could be found.

RECOMMENDATIONS.

Do not wait for the leaves to become curled, but spray thoroughly as soon as the first few lice are observed. Much depends upon the thoroughness of the first application.

Direct the spray from below so as to drench the under surface of the leaves.

Use a solution of good whale-oil soap, not weaker than 1 pound to 7 gallons of water.

When the spraying has been neglected until the leaves have become badly curled, trim off the curled tips and spray at once with the whale-oil soap solution. This applies especially to fruit trees.

In the case of currants and gooseberries, it will sometimes be found practical to pick off and destroy the leaves which are first infested in the spring.

NATURAL ENEMIES OF PLANT LICE.

Plant lice are preyed upon by both predaceous and parasitic insects. These insects may be classed among those friendly to the farmer, because of the good they do by checking the increase of noxious species.

Among the most prominent of the predaceous insects which feed upon plant-lice are the lady bird beetles. Both the larvæ and mature insects devour the lice. These insects will always be found where plant-lice are abundant. The following are among the species observed during the past season:

PREDACEOUS INSECTS.

Anatis ocellata Linn. (*15-punctata* Oliv.).—This insect undoubtedly feeds on various species of plant lice. Although common on the currant bushes, the writer found it much more common during the past year upon the plum trees. During the latter part of May and until the middle of July, the insects could be found upon the trees in all stages of development. At Plate XXVI, fig. 7, the larva is shown natural size and enlarged, the pupa at Fig. 8 and the mature insect, natural size, at Fig. 10. Fig. 9 is from a photograph of a plum with one of the pupæ attached. These pupæ do not seriously injure the fruit. The skin of the plum is not broken, as the larva, when about to pupate, attaches itself to the fruit merely by a gummy secretion from the tip of the abdomen.

There are a number of other species of lady-bird beetles which attack both plum and currant plant lice. The following are among those which were observed as being most common last season: The nine-spotted lady-bird beetle, *Coccinella 9-notata* Hbst.; the two-spotted lady-bird beetle, *Adalia bi-punctata* Linn.; a small reddish brown or brick red species having a black dot in

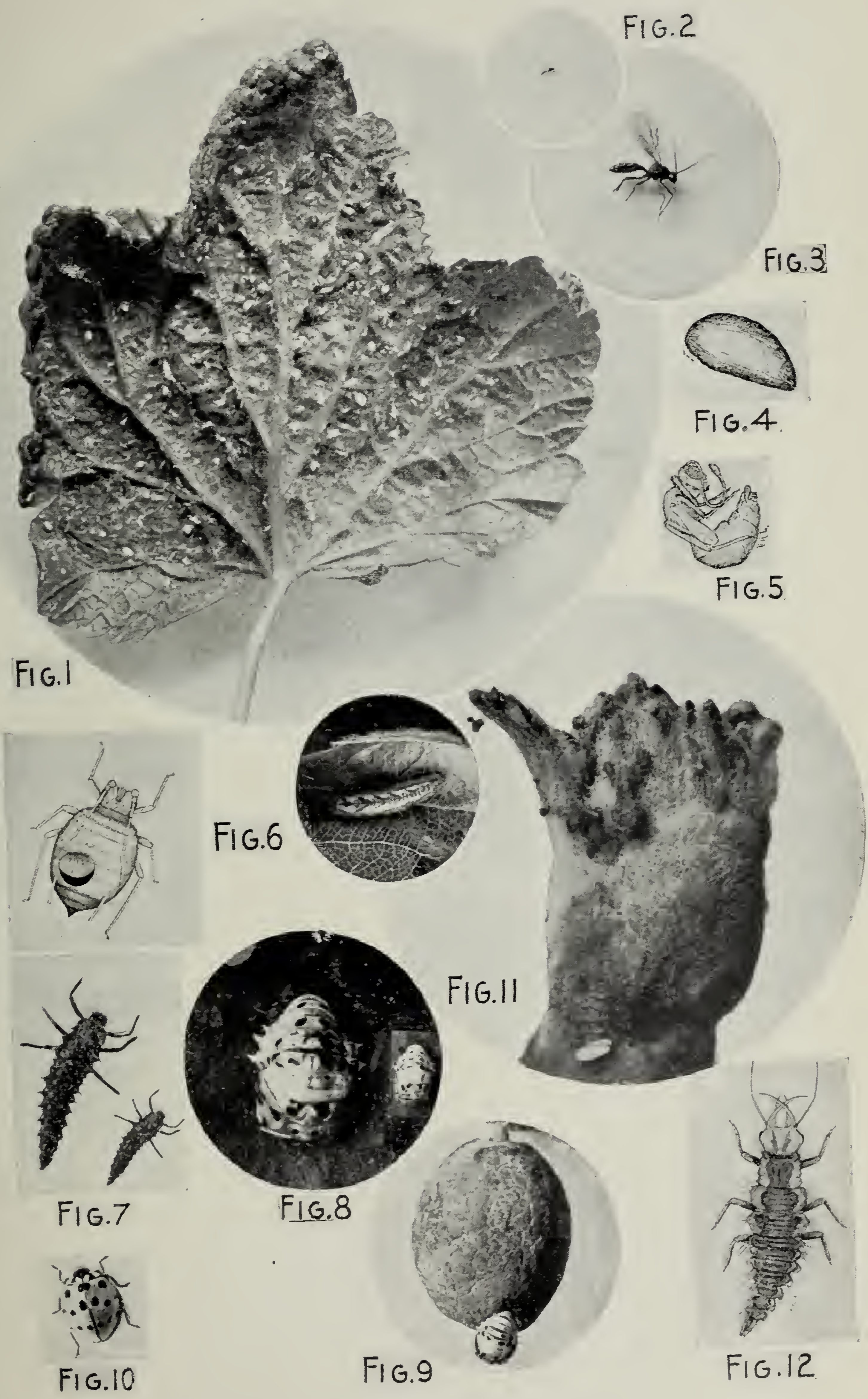


PLATE XXVI.—ENEMIES OF PLANT LICE.

each elytra; the ten-spotted lady-bird beetle, *Megilla maculata* DeG. This species is red with ten black spots on the elytra.

Plant lice are also preyed upon by syrphus fly larvæ. A photograph of a common species, natural size, is shown at Plate XXVI, fig. 11. The egg, attached near the base of an opening apple leaf bud, is also shown, enlarged to about four times natural size. These larvæ suck the juices from the bodies of the plant lice, thus quickly causing their death. When full grown the larva forms an oblong green or brown puparium, larger at one end, and usually attached to the under surface of the leaf. In a few days a two-winged fly emerges. This is the mature insect which lays the egg.

Another species of syrphus-fly larva which has been much more common on the plum trees during the past season than the species referred to, is smaller and of a yellowish brown color. Specimens which appeared to be about full grown were measured July 20. The average dimensions were 2.4 mm. by 0.78 mm. Eggs were also found on this date. They were pearly white, oblong, slightly oval, rounded at each end and measured 0.87 mm. by 0.33 mm.; the shell brittle, and sculptured with heavy parallel, longitudinal lines of a dull white crossed by oblique parallel lines of the same shade. Every attempt to breed this species in the laboratory failed and neither pupæ nor the mature insects were observed. The larvæ were very abundant. From May until October a few of them could be found upon almost every infested leaf. Frequently they were entirely hidden from view by the large number of plant lice and the white powdery substance with which the lice are dusted so that the only indication of their presence was the brown, shriveled skins of the dead lice. It is probably within bounds to say that these larvæ destroyed nearly forty per cent of the plum lice in the Station orchard last season.

There are still other kinds of insects which feed upon plant lice. Among them the most common are the aphis lions. These ferocious creatures are the larvæ of delicate winged insects known as the lace-winged flies. The mature insects are very delicate and have finely veined green wings. The eggs are

laid singly on the tips of stiff stalks of silk which are fastened to the leaf in an upright position. The stalks are about half an inch high. When full grown the larva rolls itself into a little ball of white silk from which the mature insect finally emerges. These voracious larvæ suck the juices from their victims, holding the plant louse or other prey at the tips of their long jaws and sucking the liquid by means of their peculiarly arranged mouth parts. A drawing of one of these larvæ, greatly enlarged, is shown at Plate XXVI, fig. 12. When about full grown a larva of this species measures about 4.4 mm.

PARASITIC INSECTS.

The work of these little insects was much more apparent upon the currant plant lice than upon those under observation on the plum trees. No parasites were reared from the latter.

*Aphidius polygonaphia** Fitch.—This minute insect belongs to a large group of beneficial insects which are classified in the same order with the wild and tame bees, namely, the *Hymenoptera*. This parasite seems to have a special liking for the currant plant louse, *Myzus ribis*, although it is a common parasite on other species. The egg of the parasite is laid on or just under the skin of the plant louse, and when this is once done the unfortunate louse is doomed. The egg soon hatches and the minute larva feeds upon the tissue just beneath the skin, taking care at first not to touch a vital organ. By the time it has become full grown, however, nothing remains of the host but the integument. The larva transforms to the pupa within its host, the mature insect cutting its way out. A parasitized plant louse soon becomes inactive, and swells up until it is somewhat larger than the largest of its fellows. The integument becomes hard, finally almost brittle, and turns pearly white. At Plate XXVI, fig. 1, some of the parasitized lice are shown on the under surface of a currant leaf.

Although present during the entire time that the plant lice were common upon the currant, they were especially abundant

* Identified by Mr. William Ashmead.

during the latter part of May and the middle of June. June 17, the writer had a good opportunity to watch some of these minute parasites in the act of oviposition. They were flying or walking nervously about the infested leaves as if looking for just the right lice upon which to deposit their eggs. The female apparently selects a suitable part of the body of her victim upon which to place an egg, straightens her legs somewhat so as to raise her body, and brings the tip of the abdomen forward between them as far as necessary. In doing this the abdomen may be lengthened to twice its natural length and extended half its length or more beyond the head. The lice usually place the eggs upon the abdomen of the plant louse, but this is not always the case. Upon one occasion out of six parasites under observation, four placed the egg upon the abdomen, one upon the thorax and one upon the head. In all of these and many other cases under observation the plant lice upon which the eggs were laid were not more than half grown.

The time required for the eggs to hatch and the insect to mature was not observed. Both larvæ and pupæ were dissected out of parasitized lice. A drawing of the former, greatly enlarged, is shown at Plate XXVI, fig. 4; of the latter at fig. 5; and photographs of the mature insect at figs. 2 and 3.

June 18, a number of the parasites hatched from specimens kept in the laboratory. In all the cases observed the developed parasite was on its back within the body of the louse, with the head near the posterior extremity. When ready to emerge the imprisoned insect begins to cut through the walls of the abdomen with its jaws, cutting a round opening large enough to admit its body. As a rule the piece is not cut clear around, thus leaving a hinge as shown at Plate XXVI, fig. 6. It takes but a very short time for the parasite to make its way to liberty, about four minutes being the time required for those under observation.

Other species bred from *Myzus ribis* by the writer are *Isocratus vulgaris* Walk. and *Pachyneuron aphidivorus** Ashm. These species were not abundant.

*Identified by Mr. William Ashmead.

SPECIES OF PLANT LICE UNDER OBSERVATION.

These include two, *Hyalopterus pruni* Fab., which has been very abundant on the plum during the past season, causing serious injury to the trees, and *Myzus ribis*, which has been equally abundant and injurious on the currant.

ATTACKING THE PLUM.

Hyalopterus pruni Fab.

This species attacks the leaves of the plum, collecting in large numbers on the under surfaces. The lice multiply rapidly, becoming so thick as to cover the entire under surface of the leaves (Plate XXVII, fig. 10), causing them to curl and wilt. Their bodies are covered with a bluish-white, mealy powder. Much injury was caused in both orchards and nurseries by these lice last season. In the Station orchard all of the varieties of plums were attacked during the time when the lice were naturally most numerous, but toward the latter part of the season but few could be found excepting on the native varieties.

History and present distribution.—So little attention has been given this insect by writers on economic entomology that it is difficult to learn its history. It is probably of European origin. It was first described by Fabricius who lived in the latter part of the seventeenth century. According to Bucton this species was also mentioned by several early European writers.

The insect is now known to occur in Germany, England, Australia and New Zealand, and is probably distributed over a considerable portion of the eastern United States. It has been found as far west as Iowa. It occurs in abundance in the western part of this State.

Food plants.—The plum seems to be the principal food plant of this species. It is said to infest the leaves of the grape, peach, nectarine and apricot in Europe. It is known to migrate from the plum to a species of grass, *Phragmitis communis*. According to H. Osborne and F. A. Sirrine* it also infests the choke cherry.

*Insect Life, Vol. I, p. 235.

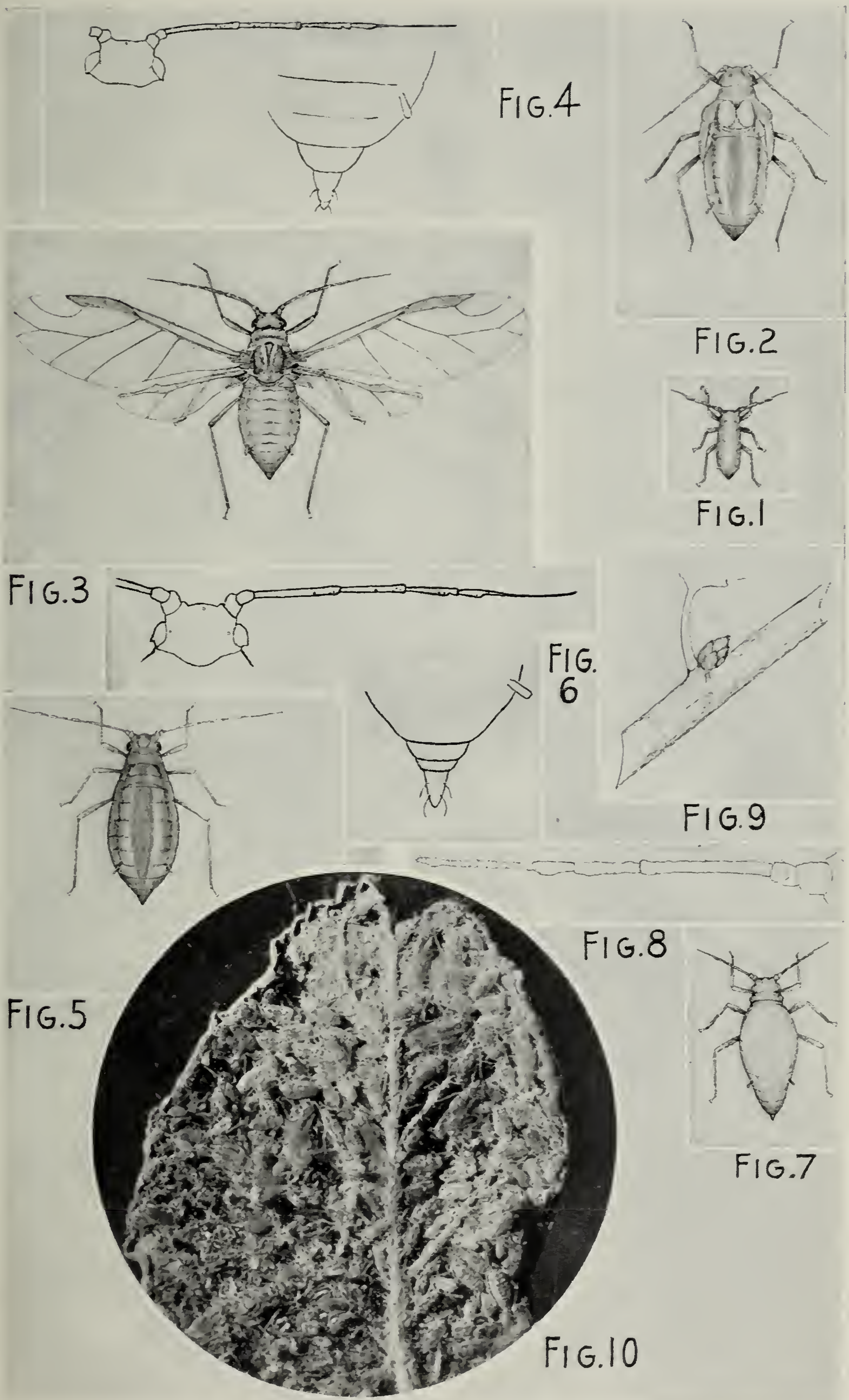


PLATE XXVII.—*Hyalopterus pruni*, PLANT LOUSE OF PLUM.

Descriptions and notes on life history.—The writer's attention was first called to this species early in June. At this time most of the plum trees in the Station orchard were very badly infested with this and other species of plant lice. Most of the lice of this species were wingless and were present in all stages of development. Pupæ and winged forms were much less numerous.

The larva.—The very young larva of average size measures about 0.5 mm. in length. The lateral margins of the body are nearly parallel, but the body is usually slightly broader near the posterior extremity. The general color is pale green with a slightly bluish tinge. The antennæ are six-jointed. Joints I, II, are shorter and sub equal in length. Eyes red, legs stout, nectaries about as long as thick. The larvæ, like the mature lice, are covered with a bluish white powder. (Plate XXVII, fig. 1.)

Apterous viviparous female.—Size of body 2.67 mm. by 0.99 mm. General color pale or yellowish green, with slightly darker green mottling. A medio-dorsal line of darker green, widest at about the middle, extends from the head to the cauda. Eyes dark reddish brown. All appendages nearly colorless or very light green, with the exception of the anterior half of the fifth and the entire sixth joints of the antennæ, the tips of the posterior tibiæ and the tarsi, which are dusky. Rostrum reaches nearly to the second coxæ. Antennæ slender, about two-thirds length of body. Joints III, IV and V sparsely tuberculated. Length 1.77 mm. Joints I, II and VI shortest (III, 0.45 mm.; IV, 0.3 mm.; V, 0.25 mm.; VI, 0.125 mm.; VII, 0.45 mm.). Nectaries dusky; very short, 0.09 mm. in length, about half as broad, and slightly restricted at base. Legs slender, cauda prominent, slightly curved upward, 0.18 mm. in length by 0.12 mm. at base, tapering toward the tip and furnished on either side with two slender backward curved hairs. (Plate XXVII, figs. 5 and 6.)

The apterous females were found on the native plums in the Station orchard until the latter part of September, when only an occasional individual could be found.

Winged viviparous female.—Body more slender than apterous female. Size of body 2 mm. by 0.74 mm. General color the same as the apterous female. Head and prothorax usually somewhat darker green. Antennæ slender, slightly dusky with the exception of the basal third of the third joint, which is pale green. Prothorax and thoracic lobes darker green. Apical third of femora and tibiæ, entire tarsi and nectaries slightly dusky. Abdomen pale yellowish green with four to six triangular medio-dorsal green marks ranged transversely. Front of head not conical. Measurements of antennæ about the same as in apterous female. Wings hyaline, expanse 6.9 mm., veins yellowish green; stigma narrow. Nectaries and cauda as in apterous viviparous female. (Plate XXVII, figs. 3 and 4; pupa shown at fig. 2.)

The winged females were on the plums in more or less abundance during the entire summer. During the latter part of July, August and most of September but few winged females were found and most of these were on the native plums with colonies of young.

During the early part of September (September 8) the lice were observed to be more abundant in the Station orchard. A few scattering colonies of winged females and young were found on all varieties of plums. These colonies evidently became more numerous toward the middle and latter part of the month. Oviparous females were first observed about the middle of October, and could occasionally be found on the trees until the first of December. The males were not positively identified. The first winter eggs were found November 11. They were on the twigs, most of them near the winter buds as shown at Plate XXVII, fig. 9.

Oviparous female.—Body oblong, rounded above and tapering to posterior extremity. Size of body 1.33 mm. by 0.5 mm. General color pale green. A medio-dorsal line of darker green extends from the head to about two-thirds the entire length of the abdomen and two faint, green sub-dorsal lines close to the lateral margin, extend the entire length of the abdomen. Antennæ six-jointed; length 0.72 mm. (III, 0.05 mm.; IV, 0.23 mm.; V, 0.05 mm.; VI, 0.22 mm.) Plate XXVII, figs. 7 and 8.

Winter egg.—Color pale green at first, varying to darker shades. Measurements 0.6 mm. by 0.25 mm. Oblong oval in shape, slightly curved and obtusely rounded at the ends.

Partial bibliographical list:

1857. Koch, C. L. Die Pflanzenlause—Aphiden. pp. 22-23. Descriptions of larva and apterous and winged viviparous females. Figures of apterous and winged viviparous females.

1877. Bucton, G. B. Monograph of British Aphides. Vol. II, pp. 110-111. Descriptions and figures of apterous and winged viviparous females.

1892. Herbert Osborne and F. A. Sirrine. Insect Life. Vol. V, p. 236. *Hyalopterus arundinis* Fab. (equals *pruni* Fab.) on plum and choke cherry.

Other species attacking the plum.—Six or more species are known to attack the plum. Among those observed by the writer last season are the following:

Hyalopterus arundinis Fab. This species closely resembles the preceding. According to Bucton, it differs in both size and habits

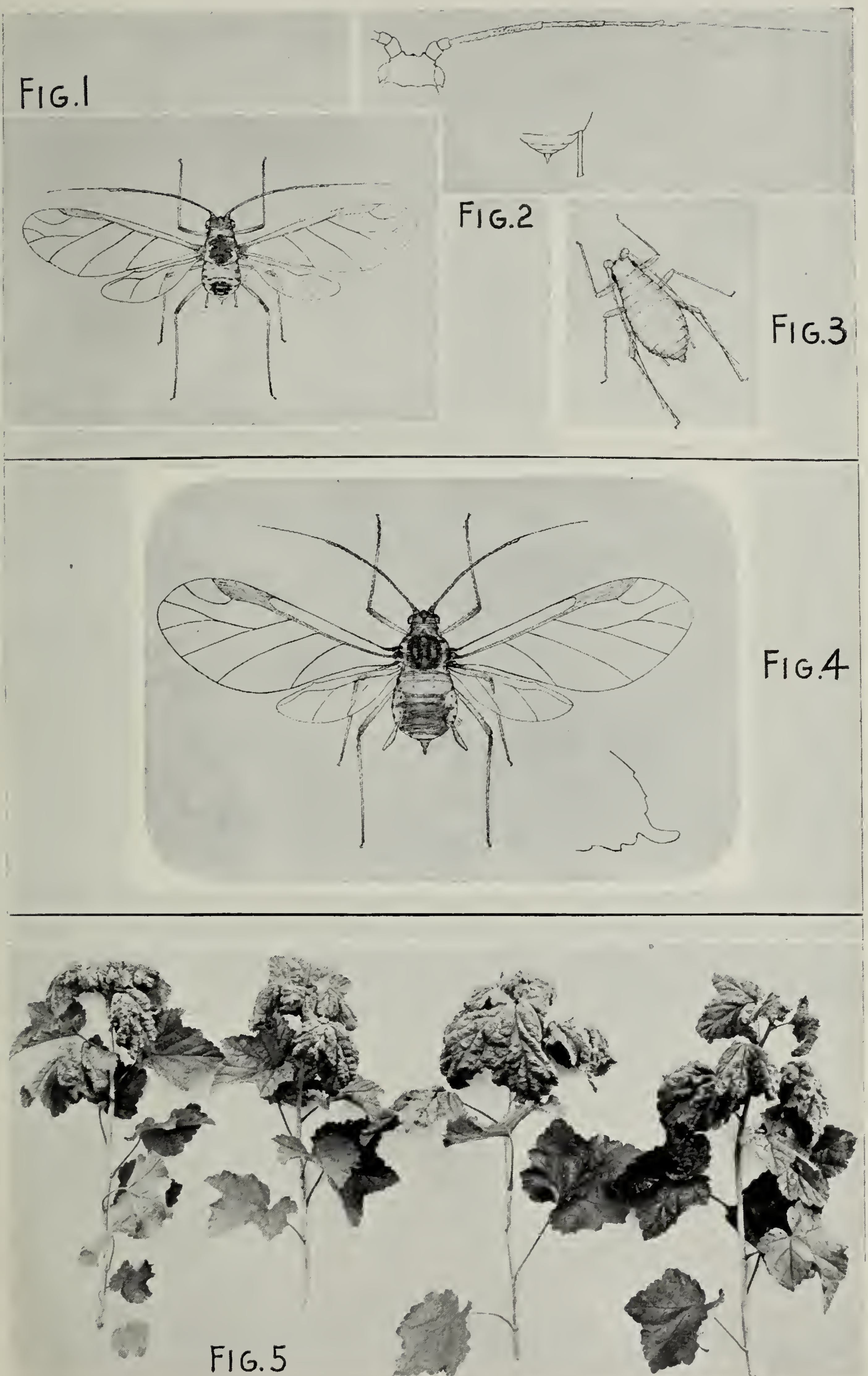


PLATE XXVIII.—PLANT LICE OF CURRANT.

from *H. pruni*, being smaller and more active. Other structural differences are very slight, if any. The markings on the thorax are slightly different. This species was found closely associated with *H. pruni*.

*Aphis pruni** Fab. A common species on the plum. Numerous early in the season. Winged females (migratory brood) with young scattered through the Station orchard during the latter part of September and early in October.

Phorodon humuli. During August, September and October occasional individuals were found in the plum orchard. August 26 a few apterous and winged females with larvæ were found on the plum leaves.

ATTACKING THE CURRANT.

Myzus ribis Linn.

This species is especially injurious to the red currant. The lice cause red bladder-like galls to form on the leaves. A badly infested leaf becomes greatly distorted and curled as the result of these gall formations, as shown in Plate XXVIII, fig. 5. The degree to which the leaves are distorted by the lice seems to be influenced by the variety of currants. In the Station garden the leaves of Fay and Cherry currants were distorted by the lice much more than those of the London Red, although all three were infested equally and by the above species.

The injury caused by the lice was very apparent in the Station garden. The leaves dropped from the bushes and the fruit was injured both by premature ripening and by the black fungus which grows in the honey dew secreted by the lice.

History and present distribution.—This species is probably of European origin. It is widely distributed throughout the eastern part of the United States, occurring from Maine to Illinois and probably further west. It is also well known in Canada.

Food plants.—Besides the red currant, it infests the black currant and gooseberry.

Descriptions and notes on life history.—The winter eggs hatch soon after the leaves open. Last year by May 13 the lice had be-

*Identified by Mr. Th. Pergande.

come quite numerous on the currant bushes in the Station garden. The galls had just begun to form and some of them were tinged with red. Each of the galls was occupied usually by but one female with three or four young. The lice were multiplying very rapidly at this time and toward the latter part of May had become sufficiently abundant to do serious injury.

The apterous and winged viviparous females have been described by Bucton* as follows:

Apterous viviparous female.—Size of body 2.14 mm. by 1.01 mm.; length of antennæ 2.27 mm.; length of cornicles 0.37 mm. Long oval, shining green, with darker green mottlings. Front flat, garnished with short bristles, as also are the sides. Antennæ long and very fine. Cornicles cylindrical and pale green. Eyes bright red. Cauda obtuse. Legs yellow or greenish. Bristles capitate.

Winged viviparous female.—Expanse of wings 7.62 mm.: size of body 2.54 mm. by 1.13 mm.; length of antennæ 2.27 mm.; length of cornicles 0.50 mm. Bright greenish yellow. Head pale olive. Eyes red. Three ocelli obvious. Antennæ fixed on small tubercules. Prothorax with an indented olive band. Thoracic lobes brown. A stellate spot is seen on the post thorax, succeeded by six or seven irregular transverse bands on the abdomen of varying thickness; four or five spots on each lateral edge. Cornicles green or olive, cylindrical, or at least very slightly lavate. Legs green, with olive femoral points and tarsi. Wings broad with yellow insertions, greenish cubitus and veins.

During the latter part of July nearly all the lice disappeared from the currants and gooseberries. There still remained, however, an occasional apterous female on the old leaves.

These females could be occasionally found as long as the leaves remained on the bushes and were always accompanied by from two to four or five larvæ. They were very light green in color and about two-thirds as large as the apterous viviparous females found earlier in the season. (Plate XXVIII, fig. 3.)

The male lice were first observed toward the latter part of October (Oct. 21).

The male.—Size of body 1.15 mm. by 0.45 mm.; expanse 5.95 mm. Yellowish green. Head dark or olive green. Meso-thorax mottled with irregular dark green spots, and the abdomen with from three to six dark spots along the lateral dorsal margins, and a broad, broken transverse dorsal band of the same color on the posterior half.

* Monograph of British Aphides, Vol. I, pp. 180, 181.

Antennæ olive green, slender, 2.85 mm. in length (Joint III, 0.65 mm.; IV, 0.4 mm.; V, 0.4 mm.; VI, 0.125 mm.; VII, 1.1 mm.). Third, fourth and fifth joints tuberculate. Sensoria very numerous. Eyes deep red. Legs yellowish green with the exception of the anterior third of the femora, tips of the tibiæ and the tarsi, which are dusky. Nectaries yellowish green, cylindrical, slightly dilated, 0.22 mm. in length. Veins dark, stigma light yellow or yellowish green, 8 mm. in length. (Described from one specimen in balsam.) Plate XXVIII, figs. 1 and 2.

The eggs are shining black. A few were found on the twigs during the latter part of October. They were much more numerout about a month later.

Partial bibliographical list:

1857. Koch, C. L. "Die Pflanzenlause—Aphiden," pp. 39-40. (*Rhopalosiphum ribis* Linn.) Descriptions. Ill. apterous and winged viviparous females.

1867. Walsh, B. D. Practical Entomologist, Vol. II, p. 106. Method of work.

Ibid, pp. 109-110. Gives account of work of Coccinellidæ against plant lice.

Riley, C. V. Prairie Farmer, Vol. V, n. s., p. 69. Means against.

1869. Walsh, B. D. American Entomologist, Vol. I, p. 250.

1870. Riley, C. V. Second Missouri Report, p. 110.

1873. Riley, C. V. Sixth Missouri Report, p. 46.

1876. Bucton, G. B. Monograph British Aphides, Vol. I, pp. 180-181. Descriptions apterous and winged viviparous females and pupa. Illustrations of apterous and winged viviparous females.

1878. Thomas, Cyrus. Third Report (Eighth Annual Report of the Entomologist of Ill.) pp. 76-78. Gives Bucton's descriptions with notes on possible varieties of *M. ribis.*

1883. Saunders, J. H. Insects Injurious to Fruits, p. 351. Brief notes.

1887. Oestlund, O. W. Synopsis of the Aphididæ of Minn., p. 73 (Bul. No. 4 Geological and Natural History Survey of Minn.) Technical descriptions.

1894. Harvey, F. L. Annual Report Maine Agricultural Experiment Station, 1894, p. 109. Notes, injury caused to gooseberry bushes.

*Other species attacking the currant.—Rhopalosiphum ribis** Linn. This species is especially common on the black currant.

It also attacks the red currant. The black currants in the Station garden were badly infested last season. During the latter part of July the lice left the currants. Return migrants (Plate XXVIII, fig. 4), appeared on the bushes early in October. The

*Identified by Mr. F. A. Sirrine.

oviparous females and the males were first observed October 21, and the former were found until late in November.

Several females of this migratory brood were measured with the following results: Size of body 2.05 mm. by 1 mm. Expanse 8.9 mm.; length of antennæ 2.95 mm.; cornicles 0.45 mm. The markings on the thorax and abdomen vary. In some instances the spots are more irregular and broken than shown in the figure. The lateral dorsal edges of the abdomen are also marked with small, irregular black spots.

Oviparous female.—Size of body 1.6 mm. by 0.7 mm. General color dull or olive green. Tips of femora, tibia and the tarsi reddish brown. Antennæ 1.9 mm. (Joint III, 0.52 mm.; IV, 0.3 mm.; V, 0.25 mm.; VI, 0.1 mm.; VII, 0.6 mm.) Eyes red. Cornicles, 0.45 mm.; dilated near middle, restricted at base, dusky on extreme tips. Cauda prominent, light green, 0.15 mm. in length. (Described from specimen in balsam.)

Male.—Size of body 1.55 mm. by 0.85 mm. General color yellowish green. Head dark green or brown. Meso and meta thorax and abdomen mottled with darker brown or black. From three to four dark spots on lateral dorsal margins of abdomen. Eyes red, antennæ on slightly raised tubercules. Length, 3.05 mm. (Joint III, 0.75 mm.; IV, 0.5 mm.; V, 0.4 mm.; VI, 0.15 mm.; VII, 0.95 mm.) Legs yellowish or light green with the exception of the anterior third of the femora, tips of tibiæ and the tarsi, which are dark brown or black. Cornicles yellowish or light green, dilated, restricted at base, 0.45 mm. in length. Cauda same color as cornicles, 0.15 mm. in length, tapering, obtusely rounded at apex. (Described from specimen in balsam.)

The eggs are shining black and are placed on the twigs.

Several other species occasionally occur on the currant, but none of them were noticed during the past season in sufficient numbers to do serious injury.

REPORT

OF THE

Department of Animal Husbandry.

W. H. JORDAN, Director.
WILLIAM P. WHEELER, First Assistant.
C. G. JENTER, Assistant Chemist.

Table of Contents.

REPORT OF THE DEPARTMENT OF ANIMAL HUSBANDRY.

PART I.

I. THE SOURCE OF MILK FAT.*

W. H. JORDAN AND C. G. JENTER.

SUMMARY.

(1) A cow fed during ninety-five days on a ration from which the fats had been nearly all extracted, continued to secrete milk similar to that produced when fed on the same kinds of hay and grain in their normal condition.

(2) The yield of milk fat during the ninety-five days was 62.9 lbs. The food fat eaten during this time was 11.6 lbs., 5.7 lbs. only of which was digested, consequently at least 57.2 lbs. of the milk fat must have had some source other than the food fat.

(3) The milk fat could not have come from previously stored body fat. This assertion is supported by three considerations: (1) The cow's body could have contained scarcely more than 60 lbs. of fat at the beginning of the experiment; (2) she gained 47 pounds in body weight during this period of time with no increase of body nitrogen, and was judged to be a much fatter cow at the end; (3) the formation of this quantity of milk fat from the body fat would have caused a marked condition of emaciation, which, because of an increase in the body weight would have required the improbable increase in the body of 104 lbs. of water and intestinal contents.

*Reprint of Bulletin No. 132.

(4) During fifty-nine consecutive days 38.8 lbs. of milk fat was secreted and the urine nitrogen was equivalent to 33.3 lbs. of protein. According to any accepted method of interpretation, not over 17 lbs. of fat could have been produced from this amount of metabolized protein.

(5) The quantity of milk solids secreted bore a definite relation neither to the digestible protein eaten nor to the extent of the protein metabolism. In view of these facts it is suggested that the well-known favorable effect upon milk secretion of a narrow nutritive ratio is due in part to a stimulative, and not wholly to a constructive, function of the protein.

(6) The composition of the milk bore no definite relation to the amount and kind of food.

(7) The changes in the proportion of milk solids were due almost wholly to changes in the percentage of fat.

INTRODUCTION.

Among the problems important in agriculture that are most difficult of solution are those which pertain to animal metabolism They are difficult because the field of chemical activity where the processes of digestion and reconstruction of compounds occur is inaccessible to the ordinary direct means of study and observation. For this reason such questions as the sources of the fats and other compounds that are formed in the animal body are still only partially answered. Especially inconclusive is the knowledge pertaining to the formation of milk fats. A widespread popular belief is that they as well as other fats must first exist in the food, the function of the animal organism being merely to collect and transfer them into the adipose tissue or milk. Apart from certain experimental evidence which proves the possible formation of animal fats in other ways, there is one fact that appears to render this view untenable, which is that great unlikeness exists in the mixtures of fats that different species construct from the same foods. There seems to be no possibility, either, of simply transferring from any ordinary ration a mixture of fats similar in kind and proportions to that found in tallow, lard or

milk. Moreover, the construction of animal body fats from the carbohydrates of the foods is now experimentally established beyond reasonable doubt. The investigations of Lawes & Gilbert, Henneberg, Soxhlet, B. Schulze, Tscherwinsky, Chaniewski, E. Voit, Lehmann, Munk and Rubner, show most clearly that with sheep, pigs, geese and dogs the body fat accumulated could not have come wholly from the protein and fats in the food eaten, and, therefore, must have been formed in part, at least, from starch and similar compounds.

It should be said, however, that neither these nor other experiments demonstrate that food protein and fat may not take part in the construction of body fat, but prove simply that carbohydrates do. The possibilities of food protein and fat in their relation to fat formation in the animal body are not yet clearly understood.

Concerning the sources of milk fat our knowledge is less definite. The experiments of Boussingault, Voit, Wolff, G. Kuhn and M. Fleischer are the ones that have been so far carried on for the purpose of obtaining information upon this particular point. The evidence which they furnish is entirely negative, because in all cases the fat of the foods plus the possible fat from the metabolized protein was, according to the interpretations of the several investigators, wholly or nearly sufficient to account for all the fat in the milk. In fact, none of these experiments was so planned or so long continued as to make safe conclusions possible. Soxhlet has recently declared his belief that under certain conditions milk fat may in part be formed from body fat, but his conclusion must be regarded as inferential, for he presents no experimental proof of his theory.

It must be admitted that the production of milk fat involves some conditions not pertaining to the formation of body fat. The former is, according to the general concensus of opinion, the peculiar product, like all other milk solids, of specialized tissues called the mammary glands, the immediate location in these glands of these particular metabolic changes being the epithelial cells of the alveoli. A histological study of these cells when in a

state of activity has led some physiologists to believe, not without a show of reason, that milk is the result of the breaking down or liquefaction of proteid tissue in the udder, the food serving merely to rebuild this tissue. Certainly such a theory cannot be regarded as unreasonable in view of the observations which appear to show the formation of beeswax from protein, the fatty degeneration of proteid tissue under the influence of phosphorus poisoning and the apparent production of fat from protein by fly maggots. We have, besides, the generally observed and well-established fact that an increase in the supply of protein in the ration of milch cows often stimulates the secretion of milk in a marked manner, even though there is no increase in the total digestible food consumed.

It must be confessed, however, that the data so far recorded concerning the source of fat are confusing and inconclusive when we attempt to apply them to the narrower question of the formation of milk fat.

It has been for some time the opinion of the writer that in order to reach definite conclusions as to the source of milk fat through experiments conducted without the use of a respiration apparatus, the following conditions, among others, must be secured:

(1) The use of foods either fat-free or containing such small percentages of fat that, if the milk was formed in the usual quantity, a large balance must come either from the cow's body or from the other two classes of food compounds, viz.: protein and carbohydrates.

(2) The continuation of the experiment over so long a period of time as to show conclusively whether, in the absence of food fat, the cow did or did not draw upon a previous store of body fat for the production of milk fat.

(3) The variation of the protein of the food from a quantity below to one above the actual needs of the animal in order to discover, if possible, the minimum protein metabolism necessary to the maintenance of a given production of milk fat.

(4) The observation through this entire long period of time of such data as would enable the experimenter to keep nitrogen and fat balances, which of necessity would include a determination of the urea nitrogen or the amount of metabolized protein.

THE PLAN, MATERIALS AND PROCEDURE OF THE EXPERIMENT.

During the past year an attempt was made at this Station, with a gratifying degree of success, to conduct an experiment in accordance with the conditions previously outlined, the main object of which was to discover the necessary relation which may exist between any class of compounds in the food and the production of milk fat.

THE PLAN OF THE EXPERIMENT.

The plan of the experiment, as finally executed, involved the following:

(1) The feeding of normal foods for a period of about two weeks, followed by the same foods from which the fats had been extracted during ninety-five days, all of which were weighed and analyzed especially for nitrogen and fats.

(2) Changes in the rations from a minimum of 15 lbs. of air-dry food to a maximum of 22½ lbs., and from a minimum of 1.3 lbs. of total protein to a maximum of 3.06 lbs. These changes were so arranged that during a certain period a decrease of protein was accompanied by an increase of carbohydrates.

(3) The analysis of the milk for one hundred and two days.

(4) The collection and analysis of the urine and feces from the experimental animal for sixty-six days, this being done continuously during fifty-nine days of the time in which extracted foods were fed.

(5) A study of the distribution of certain mineral constituents of the food in the milk, urine and feces. (Incidental and not completed.)

(6) A study of the distribution of the energy of the food in the milk, urine and feces. (Incidental and not completed.)

The experimental animal stood in a stall the floor of which was covered with metal, the trench behind being practically a metal lined box, this construction making it possible to recover any excreta that through accident might fall to the floor.

The daily ration was fed in three equal portions, morning, noon and night. Water was offered at stated times, and the animal was weighed at the same hour each day. Two men were employed for the collection of the urine and feces, one during the night and the other during the day. The excreta were caught in tin vessels, the one used for the urine being so constructed as to prevent loss of the liquid by spattering. As far as known there was loss of these materials in but a single instance and that was small.

The weights of urine and feces represent that which was voided during twenty-four hours from six o'clock a. m.

The Foods.

The first matter requiring attention in the experiment herein reported was the selection or preparation of foods containing small quantities of fat. In certain grain foods, such as rice, barley and peas, the percentages of fat are comparatively low, and if these could have been fed unaccompanied by any coarse fodder the selection of a ration would have been a much simpler matter. Under the circumstances, it was decided to attempt to extract the fats from some of the ordinary cattle foods by treating them with a light benzol. It was clearly impossible to do this by any means at our command, and, therefore, we sought the coöperation of some manufacturer engaged in the extraction of vegetable oils The Cleveland Linseed Oil Company, of Cleveland, Ohio, very kindly undertook to do the work for us, and, consequently, we shipped to their works at South Chicago a thousand pounds of finely chopped hay and about fifteen hundred pounds each of corn meal and ground oats. The extraction of these materials evidently was found to be troublesome, requiring repeated treatment, and while the fats were not entirely removed, this Station is under great obligations to this company for giving the work such faithful and efficient attention as to make our experiment possible.

The following is a statement of the composition of these foods before and after extraction. It is seen that the amount of fat left in the treated materials was so small that it was possible to feed the animal a fairly generous ration that contained not over thirteen hundredths of a pound of petroleum ether extract daily, probably not all of which was pure fat or oil. In order to control the protein supply in the ration, use was made of wheat gluten, which contained, as the analyses show, from seventy-two to seventy-four per cent of protein.

COMPOSITION OF FOODS.

Laboratory number.	FOODS.	Water.	Nitrogen.	Protein.*	Fat (petroleum ether extract).
		Per cent.	Per cent.	Per cent.	Per cent.
61	Timothy hay, normal.......	10.46	0.99	6.24	1.62
70	Timothy hay, extracted.....	8	.95	5.94	.71
120	Timothy hay, extracted.....	8.02	.99	6.24	.75
261	Timothy hay, extracted.....	7.55	.91	5.69	.71
286	Timothy hay, extracted.....	7.79	1	6.25	.72
63	Corn meal, normal..........	14.55	1.38	8.62	4.22
84	Corn meal, extracted.......	11.23	1.48	9.25	.38
121	Corn meal, extracted.......	10.80	1.47	9.19	.38
211	Corn meal, extracted.......	10.67	1.48	9.25	.37
231	Corn meal, extracted.......	10.79	1.52	9.50	.44
271	Corn meal, extracted.......	10.27	1.52	9.50	.40
287	Corn meal, extracted.......	11.58	1.51	9.44	.49
62	Oats, normal................	11.89	2.04	12.24	4.20
80	Oats, extracted.............	8.46	2.23	13.38	.65
122	Oats, extracted.............	8.22	2.20	13.20	.61
212	Oats, extracted.............	9.10	2.30	13.80	.66
232	Oats, extracted.............	9.22	2.27	13.62	.65
272	Oats, extracted.............	8.87	2.38	14.28	.65
288	Oats, extracted.............	9.60	2.32	13.92	.63
64	Wheat gluten, as received...	6.48	12.79	72.9	.87
85	Wheat gluten, extracted....	5.09	13.07	74.5	.05
123	Wheat gluten, extracted....	5.09	13.03	74.3	.05
233	Wheat gluten, extracted....	4.47	12.87	73.3	.04
273	Wheat gluten, extracted....	5.01	12.68	72.3	.03
289	Wheat gluten, as received..	6	12.80	73	.61

*With hay and corn meal, protein=N×6.25; with oats, protein=N×6; with wheat gluten, protein=N×5.7.

THE ANIMAL.

The animal selected for use in this experiment was a young grade Jersey cow of a vigorous type. When the experiment was begun, she was somewhat thin in flesh and about four months advanced in the period of lactation. The vigorous appetite which

she possessed was depended upon to secure entire consumption of the foods which had been treated in such a manner as to render them somewhat less palatable. It is a matter of congratulation that the regular consumption of the rations was accomplished with a very satisfactory degree of success, considering the conditions under which the experiment was carried on. The health of the animal did not appear to be impaired by the food and treatment which she received.

COMPOSITION OF THE RATIONS.

The ingredients and quantities of the several rations are given in detail below:

RATIONS.

INGREDIENTS.	NORMAL.	EXTRACTED.			
	No. 1.	No. 2.	No. 3	No. 4.	No. 5.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Timothy hay	10	10	10	10	6 2-3
Corn meal	6	6	6	7½	5
Oats, ground	5	5	5	5	3 1 3
Wheat gluten	1	1	1½	....	....
Total	22	22	22½	22½	15

THE SEQUENCE AND CHARACTER OF THE RATIONS.

Ration 1. From noon April 12 to morning April 26.
This consisted of normal foods containing all their fats.

Ration 2. From noon April 26 to morning May 11.
This ration was the same in kind and quantity as No. 1, only the fats had been largely extracted from the several foods.

Ration 3. From noon May 11 to morning May 18.
This ration was similar to No. 2, except that ½ lb. more of wheat gluten was fed daily in order to increase the proportion of protein up to or beyond the probable full requirements of the animal for maintenance and milk production.

Transition period. From noon May 18 to morning May 23.

During this period the wheat gluten was decreased ¼ lb. per day and the corn meal was increased by the same amount, the purpose being to diminish the amount of protein and to increase the proportion of carbohydrates up to any probable requirements of the animal for maintenance and milk production.

Ration 4. From noon May 23 to morning May 31.

Differed from No. 3 in that the wheat gluten was withdrawn from the ration and 1½ lbs. daily of corn meal was added.

Ration 5. From noon June 1 to morning June 20.

Similar to No. 4 only one-third smaller. It was expected that this ration would be considerably below the needs of the cow.

Transition period. From noon June 20 to morning June 24.

¼ lb. wheat gluten added to No. 5 each day.

Ration 2. From noon June 24 to morning July 30.

During this period the food was the same as during the two weeks succeeding April 26.

THE METHODS OF SAMPLING AND ANALYSIS.

The rations were weighed out at several different times during the course of the experiment, and each time this was done samples were taken of the various foods. The similarity in composition of these several portions indicates that the mixing and sampling were thorough.

The milk, urine and feces were taken directly to the laboratory and immediately weighed and sampled, excepting that the night's milk was kept in an ice box until morning when it was mixed with the morning's milk and a sample was then drawn from the mixture. The feces were thoroughly stirred and samples (4 lbs.) of the fresh material were taken for drying and for the nitrogen determination. The feces were dried over steam coils at a temperature not exceeding 60° C.

In general the methods of the A. O. A. C. were followed in the analyses, the only exception being that petroleum ether was used instead of sulphuric ether in extracting the fats from the foods and feces.

The justification of this change is found in the following figures, the only reasonable explanation of which is that the petroleum ether takes out less material that is not fat or oil than does the sulphuric ether. Certainly the petroleum ether would not fail to remove all the fats or oils, and therefore gives figures nearer the truth than does the usual solvent.

COMPARISON OF RESULTS OF EXTRACTION OF FATS WITH SULPHURIC AND PETROLEUM ETHERS.

Laboratory number.	SAMPLE.	Sulphuric ether extract.	Petroleum ether extract 40-50°.	Charcoal (sulph. ether) extract.
		Per cent.	Per cent.	Per cent.
61	Timothy hay	3.29	1.77	1.85
62	Oats	4.71	4.52	3.75
316	Timothy hay (extracted)	1.77	.85	.63
317	Corn (extracted)	.51	.59	.47
309	Feces (normal ration)	3.58	2.58	....
310	Feces (normal ration)	3.58	2.75	....
311	Feces (normal ration)	3.87	2.85	....
312	Feces (normal ration)	3.78	2.98	....
313	Feces (normal ration)	3.87	2.67	2.97
314	Feces (normal ration)	3.81	3	....
315	Feces (normal ration)	4.07	2.78	....
96	Feces (extracted ration)	1.17	.91	....
99	Feces (extracted ration)	1.18	.85	....
102	Feces (extracted ration)	1.18	.86	....
108	Feces (extracted ration)	1.16	.88	....
124	Feces (extracted ration)	1.46	.93	.84
127	Feces (extracted ration)	1.32	.97	....
130	Feces (extracted ration)	1.36	1.06	....
133	Feces (extracted ration)	1.45	.96	....
136	Feces (extracted ration)	1.46	.85	....
139	Feces (extracted ration)	1.41	.98	.88

Nitrogen was determined directly in fresh samples of the urine and feces. The drying of the feces at a temperature varying from 50° to 60° C. caused a material loss of nitrogen as the results clearly show.

The comparisons given are the first thirty-six or fifty-nine cases in which the nitrogen was determined in both the fresh and the air dry samples. There was but one instance in the fifty-nine comparisons where more nitrogen was not obtained from the fresh sample.

EFFECTS OF DRYING UPON THE NITROGEN CONTENT OF A COW'S FECES.

Laboratory number.	Nitrogen without drying.	Nitrogen when dried.	Daily loss of nitrogen by drying.	Laboratory number.	Nitrogen without drying.	Nitrogen when dried.	Daily loss of nitrogen by drying.
	Per cent.	Per cent.	Grams.		er cent.	Per cent.	Grams.
96	0.589	0.546	6.9	154	0.561	0.529	5
99	.589	.565	3.8	157	.525	.511	2.3
102	.576	.548	4.8	160	.500	.494	1.1
105	.551	.534	2.6	163	.463	.442	3
108	.559	.529	4.9	166	.451	.434	3.1
111	.570	.544	3.6	169	.445	.422	4.5
114	.556	.517	6.5	172	.446	.432	2.3
117	.556	.522	5.5	175	.446	.418	5.4
124	.542	.526	2.2	178	.430	.407	4.1
127	.562	.552	1.7	181	.421	.413	1.4
130	.557	.524	5.6	184	.468	.448	2.8
133	.582	.540	6.7	187	.458	.420	5.4
136	.557	.520	5.7	190	.471	.446	2.5
139	.557	.536	2.9	193	.455	.434	3
142	.553	.526	4.4	196	.438	.416	4
145	.568	.554	1.7	199	.425	.401	4.5
148	.563	.538	3.8	202	.418	.384	6.7
151	.584	.562	3.2	205	.421	.407	2.8

THE NUMERICAL RESULTS OF THE EXPERIMENT.

A large amount of data was necessarily recorded in an experiment involving such numerous weighings and analysis during nearly three months.

The figures herewith presented have been reduced to those which are essential to a critical analysis of our conclusions.

Those which follow are displayed under several heads:

(1) Periods represented by the several samples of foods.

(2) Daily weights of foods and content of nitrogen and fat.

(3) Daily weights and partial composition of the milk, urine and feces.

(4) Daily composition of milk, and yield of milk and milk solids.

(5) Digestibility of rations and amount of digestible food daily.

(6) Amount of water drank daily.

(7) Daily balance sheet, nitrogen and fat.

(8) Balance sheet, nitrogen, totals by periods.

(9) Balance sheet, protein, daily average for periods.

(10) Balance sheet, fat, totals by periods.

(11) Balance sheet, fat, daily average by periods.

PERIODS DURING WHICH THE SEVERAL SAMPLES REPRESENTED THE MATERIALS FED.

Timothy Hay.		Corn Meal.		Ground Oats.		Wheat Gluten.	
Sample number.	When fed.	Sample number.	When fed.	Sample number.	When fed.	Sample number.	When fed.
61	April 12–26	63	April 12–36	62	April 12–26	64	April 12–26.
70	April 26–May 18	84	April 26–May 11	80	April 26–May 11	85	April 26–May 11.
120	May 18–June 25	121	May 11–June 8	122	May 11–June 8	123	May 11–23.
261	June 25–July 1	211	June 8–16	212	June 8–16	233	June 20–28.
286	July 1–30	231	June 16–28	232	June 16–28	273	June 28–July 1.
		271	June 28–July 1	272	June 28–July 1	289	July 1–30.
		287	July 1–30	288	July 1–30		

Daily Weights of Foods and their Contents of Nitrogen and Fat.

Number of ration.	Time.	Daily Rations.				Nitrogen in food daily.	Fat in food daily.
		Timothy hay.	Corn meal.	Oats, ground.	Wheat gluten.		
		Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
1. Normal	April 12–26	4536	2721.6	2268	453.6	186.8	287.7
2. Extracted	April 26–May 11	4536	2721.6	2268	453.6	193.3	57.4
3. Extracted	May 11–May 18	4536	2721.6	2268	680.4	*221.8	†56.62
Transition period	May 18–19	4536	2835	2268	567	210.4	58.9
	May 19–20	4536	2948	2268	453.6	197.2	59.2
	May 20–21	4536	3062	2268	340.2	184.1	59.6
	May 21–22	4536	3175	2268	226.8	171	60
	May 22–23	4536	3289	2268	113.4	157.9	60.4
4. Extracted	May 23–31	4536	3402	2268	....	144.8	60.7
Extracted	May 31–June 1	1512	1134	756	....	48.3	20.2
5. Extracted	June 1–7	3024	2268	1512	....	96.5	40.5
	June 7–8	3024	2268	1512	....	97.4	40.8
	June 8–16	3024	2268	1512	....	98.3	41.1
	June 16–20	3024	2268	1512	....	98.7	42.5
Transition period	June 20–21	3024	2154	1512	113.4	111.5	42
	June 21–22	3024	2041	1512	226.8	124.4	41.5
	June 22–23	3024	1938	1512	340.2	137.3	41.1
2. Extracted	June 23–25	4536	2721.6	2268	453.6	201.2	60.9
	June 25–27	4536	2721.6	2268	453.6	192.6	59.1
	June 27–28	4536	2721.6	2268	453.6	193.1	58.6
	June 28–July 1	4536	2721.6	2268	453.6	194.2	57.9
	July 1–30	4536	2721.6	2268	453.6	197.2	63.1

*Nitrogen=222.8 grams on May 17-18.

†Fat=57.8 grams on May 17-18.

WEIGHTS AND PARTIAL COMPOSITION OF MILK, URINE AND FECES.

	DATE.	MILK.			URINE.			FECES.			
		Laboratory number.	Amount daily.	Nitrogen.	Laboratory number.	Amount daily.	Nitrogen.	Laboratory number.	Amount daily.	Nitrogen.	Fat.
	1897.		Grams.	Per ct.		Grams.	Per ct		Grams.	Per ct	Per ct.
	April 19-20..	60	8,540	0.558	65	6,761	1.123	309	15,288	0.445	0.54
	April 20-21..	68-69	8,144	.556	67	6,124	1.251	310	13,098	.439	.58
	April 21-22..	72-73	8,420	.560	71	5,472	1.368	311	15,252	.439	.60
Ration 1.	April 22-23..	75-76	8,306	.568	74	5,911	1.282	312	13,835	.403	.61
	April 23-24..	78-79	7,966	.578	77	3,664	1.809	313	14,288	.421	.54
	April 24-25..	82-83	7,995	.562	81	6,124	1.357	314	14,381	.482	.64
	April 25-26..	87-88	8,370	.563	86	6,159	1.147	315	14,99[illegible]	.450	.58
	May 3- 4..	97	6,988	.574	98	17,109	.336	96	16,025	.589	.21
	May 4- 5..	100	6,811	.662	101	21,262	.255	99	15,812	.589	.20
	May 5- 6..	103	6,910	.669	104	21,744	.274	102	17,194	.576	.19
Ration 2.	May 6- 7..	107	6,939	.656	106	16,804	.283	105	15,068	.551	.18
	May 7- 8..	110	7,045	.658	109	16,216	.333	108	16,188	.559	.20
	May 8- 9..	113	7,066	.652	112	21,064	.235	111	14,005	.570	.20
	May 9-10..	116	6,981	.664	115	12,708	.367	114	16,684	.556	.19
	May 10-11..	119	6,790	.664	118	19,476	.314	117	16,266	.556	.20
	May 11-12..	126	6,655	.658	125	21,319	.283	124	14,2[illegible]8	.542	.18
	May 12-13..	129	6,684	.663	128	20,525	.358	127	16,897	.562	.21
	May 13-14..	132	6,804	.661	131	22,510	.319	130	16,975	.557	.23
Ration 3.	May 14-15..	135	6,549	660	134	23,438	.277	133	15,904	.582	.21
	May 15-16..	138	6,357	.663	137	24,353	.230	136	15,238	.557	.18
	May 16-17..	141	6,301	.660	140	26,280	.220	139	13,693	.557	.20
	May 17-18..	144	6,351	.663	143	23,516	.220	142	16,202	.553	.18
	May 18-19..	147	6,287	.657	146	23,545	.239	145	12,538	.568	.19
Transition	May 19-20..	150	6,421	.658	149	29,867	.192	148	15,422	.563	.18
period.	May 20-21..	153	6,457	.653	152	27,443	.189	151	14,770	.584	.20
	May 21-22..	156	6,386	.655	155	20,894	.236	154	15,635	.561	.21
	May 22-23..	159	6,209	.662	158	23,417	.172	157	16,571	.525	.20
	May 23-24..	162	5,875	.661	161	17,123	.229	160	17,478	.500	.16
	May 24-25..	165	5,776	.665	164	20,277	.182	163	14,373	.463	.17
	May 25-26..	168	5,571	.655	167	19,065	.204	166	18,165	.451	.16
	May 26-27..	171	5,053	.675	170	11,794	.312	169	19,597	.445	.15
Ration 4.	May 27-28..	174	5,344	.657	173	4,508	.687	172	16,280	.446	.15
	May 28-29..	177	5,245	.665	176	10,532	.274	175	19,498	.446	.15
	May 29-30..	180	5,160	.656	179	6,520	.436	178	18,101	.430	.16
	May 30-31..	183	5,096	.648	182	8,292	.331	181	17,662	.421	.18
	May 31-Jun 1	186	4,897	.653	185	10,702	.242	184	13,934	.468	.13

Weights and Partial Composition of Milk, Urine and Feces.—(*Continued*).

	Date.	Milk.			Urine.			Feces.			
		Laboratory number.	Amount daily.	Nitrogen.	Laboratory number.	Amount daily.	Nitrogen.	Laboratory number.	Amount daily.	Nitrogen.	Fat.
	1897.		Grams.	Per ct.		Grams.	Per ct.		Grams.	Per ct.	Per ct.
Ration 5.	June 1-2....	189	5,025	0.651	188	11,666	0.289	187	14,175	0.458	0.17
	June 2-3...	192	5,110	.655	191	14,345	.212	190	10,178	.471	.15
	June 3-4....	195	5,372	.667	194	6,981	.405	193	14,303	.455	.13
	June 4-5....	198	5,401	.651	197	8,427	.374	196	18,208	.438	.13
	June 5-6 ..	201	5,450	.673	200	13,346	.232	199	19,009	.425	.13
	June 6-7....	204	5,301	.658	203	5,833	.541	202	19,668	.418	.13
	June 7-8....	207	5,344	.656	206	8.406	.350	205	20,369	.421	.14
	June 8-9....	210	5,117	.663	209	7,031	.436	208	18,839	.410	.13
	June 9-10....	215	4,862	.661	214	7,187	.415	213	16,386	.439	.14
	June 10-11....	218	4,749	.664	217	8,760	.327	216	14,799	.442	.15
	June 11-12....	221	4,869	.660	220	11,283	.276	219	12,559	.454	.14
	June 12-13....	224	4,635	.655	223	7,109	.417	222	13,615	.446	.15
	June 13-14....	227	4,713	.660	226	9,533	.281	225	13,558	.442	.15
	June 14-15....	230	4,671	.649	229	16,854	.178	228	13,055	.457	.15
	June 15-16....	236	4.642	.665	235	9,348	.270	234	12,453	.466	.18
	June 16-17....	239	4.564	.664	238	13,728	.219	237	12,984	.479	.15
	June 17-18....	242	3,154	.663	241	26,932	.114	240	13,140	.470	.15
	June 18-19 ...	245	5,308	.651	244	6,343	.356	243	11,510	.475	.16
	June 19-20....	248	4.770	.636	247	19.802	.146	246	11,184	.498	.20
Transition period.	June 20-21....	251	4,671	.660	250	7,109	.362	249	11,602	.500	.18
	June 21-22....	254	4,699	.664	253	15,132	.197	252	11,300	.488	.17
	June 22-23....	257	4,756	.661	256	23,715	.141	255	10,539	.513	.17
Ration 2.	June 23-24....	260	4.961	.656	259	9,511	.385	258	10,589	.538	.20
	June 24-25 ...	264	5,280	.640	263	5,231	.742	262	12.602	.587	.18
	June 25-26....	267	5,783	.635	266	17.237	.231	265	12,814	.623	.25
	June 26-27....	270	6,017	.623	269	16,386	.270	268	14,416	.631	.20
	June 27-28 ..	276	6,166	.642	275	16,145	.280	274	15,380	.582	.20
	June 28-29....	279	5,769	.666	278	12,772	.371	277	15,522	.531	.20
	June 29-30....	282	5.854	.689	281	12,077	.429	280	15,748	.561	.17
	June 30-July 1	285	5,793	.675	284	22,198	.239	283	15,883	.531	.19

DAILY COMPOSITION OF MILK AND YIELD OF MILK AND MILK SOLIDS.

DATE.	Solids.	Casein and albumen.	Sugar.	Fats.	Milk daily.	Total solids daily.	DATE.	Solids.	Casein and albumen.	Sugar.	Fats.	Milk daily.	Total solids daily.
	Per ct.	Per ct	Per ct.	Per ct.	Lbs.	Lbs.		Per ct.	Per ct.	Per ct.	Per ct.	Lbs.	Lbs.
April 19–20	14.85	3.50	5.22	5.33	18.83	2.8	May 15–16	15.38	4.14	5.16	5.28	14.02	2.2
April 20–21	14.82	3.47	5.55	5	17.96	2.7	May 16–17	15.53	4.13	5.27	5.33	13.89	2 2
April 21–22	15.32	3.50	5.23	5.79	18.57	2.8	May 17–18	15.35	4.14	5.11	5.30	14	2.1
April 22–23	15.32	3.54	5.52	5.46	18.31	2.8	May 18–19	15.48	4.11	5.16	5.41	13.86	2.1
April 23–24	15.24	3.61	5.45	5.38	17.56	2.7	May 19–20	15.06	4.11	5.25	4.90	14.16	2.1
April 24–25	14.57	3.50	5.34	4.93	17.63	2.6	May 20–21	15.32	4.08	5.15	5.29	14.24	2.2
April 25–26	14.70	3.52	5.36	5.02	18.46	2.7	May 21–22	15.80	4.09	5.15	5.76	14 08	2.2
April 26–27	14.42	3.60	5.26	4.76	18.08	2.6	May 22–23	15.59	4.14	5.30	5.35	13.69	2.1
April 27–28	14.15	3.65	5.29	4.41	17 96	2.5	May 23–24	15.71	4.13	5.52	5.26	12.95	2
April 28–29	14.08	3.71	5.22	4.35	17.25	2.4	May 24–25	15.42	4.16	5.16	5.30	12.74	2
April 29–30	14.19	3.80	5.24	4.35	16.60	2.4	May 25–26	15.53	4.09	5.29	5.35	12.28	1.9
April 30–May 1	13.98	3.83	5.33	4.02	13.14	1.8	May 26–27	15.26	4.22	5.19	5.05	11.14	1.7
May 1– 2	15.99	3.77	5.18	6.24	19.24	3.1	May 27–28	16.72	4.11	5.45	6.36	11.10	2
May 2– 3	14.85	4.03	5.06	4.96	15.74	2.3	May 28–29	16	4.16	5.29	5.75	11.57	1.8
May 3– 4	14.83	4.04	5 38	4 61	15.41	2.3	May 29–30	15.68	4 10	5.35	5.43	11.38	1.8
May 4– 5	14.40	4.14	5.12	4.34	15.02	2.2	May 30–31	15.64	4.05	5.37	5.42	11.24	1.8
May 5– 6	15.16	4.18	5.37	4.81	15.24	2.3	May 31–June 1	15.69	4.08	5.35	5.46	10.80	1.7
May 6– 7	14.91	4.10	5.24	4.77	15.30	2.3	June 1– 2	15.64	4.07	5.31	5.46	11.08	1.7
May 7– 8	15.12	4.11	5.22	4.99	15.53	2.3	June 2– 3	15.48	4.09	5.16	5.43	11.27	1.7
May 8– 9	15.20	4.08	5.32	5	15.58	2.4	June 3– 4	15.31	4.17	5.31	5.03	11.84	1.8
May 9–10	15.39	4.15	5.27	5.17	15.39	2.4	June 4– 5	15.53	4.07	5.42	5.24	11.91	1.8
May 10–11	14.96	4.15	5.15	4.86	14.97	2.2	June 5– 6	15.47	4.21	5.12	5.34	12.02	1.9
May 11–12	15.32	4.11	5.43	4.98	14.67	2.2	June 6– 7	15.80	4.11	5.30	5.59	11.69	1.8
May 12–13	15.84	4.14	5.27	5.63	14.74	2.3	June 7– 8	15.18	4.10	5.25	5.03	11.78	1.8
May 13–14	15.44	4.13	5.19	5.32	15	2.3	June 8– 9	15.82	4.14	5.46	5.42	11.28	1.8
May 14–15	15.32	4.13	5.15	5.24	14.44	2.2	June 9–10	15.61	4.13	5.29	5.39	10.72	1.7

Daily Composition of Milk and Yield of Milk and Milk Solids—(*Concluded*).

DATE.	Solids.	Casein and albumen.	Sugar.	Fats.	Milk daily.	Total solids daily.	DATE.	Solids.	Casein and albumen.	Sugar.	Fats.	Milk daily.	Total solids daily.
	Per ct.	Per ct.	Per ct.	Per ct.	Lbs.	Lbs.		Per ct.	Per ct.	Per ct.	Per ct.	Lbs.	Lbs.
June 10–11......	15.42	4.15	5.39	5.08	10.47	1.6	July 5– 6......	15.14	4.16	5.24	4.94	13.03	2
June 11–12......	15.55	4.13	5.35	5.27	10.74	1.7	July 6– 7......	15.38	4.16	5.35	5.07	12.66	1.9
June 12–13......	16.00	4.09	5.27	5.84	10.22	1.6	July 7– 8......	15.41	......	.....	5.23	13.13	2
June 13–14......	15.13	4.13	5.31	4.89	10.39	1.6	July 8– 9......	15.15	......	.....	5.04	12.74	1.9
June 14–15......	15.55	4.06	5.40	5.29	10.30	1.6	July 9–10......	15.07	......	.....	5	12.58	1.9
June 15–16......	15.07	4.16	5.39	4.72	10.24	1.5	July 10–11......	15.28	......	.....	5.15	12.56	1.9
June 16–17......	15.77	4.15	5.36	5.46	10.06	1.6	July 11–12......	14.99	......	.....	4.89	12.41	1.9
June 17–18......	15.12	4.14	5.39	4.79	6.95	1.1	July 12–13......	15.30	......	.....	4.93	12.58	1.9
June 18–19......	17.26	4.07	5.42	6.97	11.70	2	July 13–14......	15.28	......	.....	5.12	12.58	1.9
June 19–20......	15.92	3.97	5.33	5.82	10.52	1.7	July 14–15......	15.71	......	.....	5.20	11.84	1.9
June 20–21......	15.60	4.13	5.45	5.22	10.30	1.6	July 15–16......	15.92	......	.....	5.74	12.60	2
June 21–22......	15.43	4.15	5.47	5.01	10 36	1.6	July 16–17......	15.83	......	.....	5.34	12.69	2
June 22–23......	15.17	4.13	5.40	4.84	10.49	1.6	July 17–18......	15.27	......	.....	4.72	12.67	1.9
June 23–24......	15.79	4.10	5.39	5.50	10.94	1.7	July 18–19......	15.13	......	.....	4.58	13.21	2
June 24–25......	15.25	4	5.45	5	11.64	1.8	July 19–20......	15.05	......	.....	4.73	12.80	1.9
June 25–26......	15.77	3.97	5.38	5.62	12.75	2	July 20–21......	15.01	......	.....	4.74	12.83	1.9
June 26–27......	15.78	3.89	5.44	5.65	13.27	2.1	July 21–22......	15.21	......	.....	4.97	12.38	1.9
June 27–28......	15.64	4.01	5.42	5.41	13.60	2.1	July 22–23......	15.31	......	.....	5.14	12.60	1.9
June 28–29......	15.42	4.16	5.64	4.82	12.72	2	July 23–24......	15.40	......	.....	5.14	12.55	1.9
June 29–30......	15.68	4.31	5.33	5.24	12.91	2	July 24–25......	15.27	......	.....	5.03	11.80	1.8
June 30–July 1..	15.49	4.22	5.04	5.43	12.78	2	July 25–26......	15.63	......	.....	5.40	11.76	1.8
July 1–2.......	15.58	4.24	5.25	5.29	12.64	2	July 26–27......	15.27	......	.....	4.96	11.10	1.7
July 2–3.......	15.80	4.13	5.01	5.86	12.85	2	July 27–28......	15.69	......	.....	5.41	10.97	1.7
July 3–4.......	15.11	4.24	5.20	4.87	12.63	1.9	July 28–29......	15.96	......	.....	5.90	11.52	1.8
July 4–5.......	15.24	4.21	5.14	5.09	12.97	2	July 29–30......	15.92	......	.....	5.84	11.25	1.8

Note.—The ash is assumed to be 0.80 per cent.

DIGESTIBILITY OF RATIONS.

	Dry matter.	Ash.	Protein.	Carbohydrates	Fats.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
April 19 to 26	68.1	28.9	66.0	70.1	70.7
May 3 to 11	63.5	27.3	59.4	67.9	45.6
26 to 31	60.1	21.8	44.9	63.0	52.6
June 10 to 20	55.6	16.9	39.6	59.1	51.4

AMOUNT OF DIGESTIBLE FOOD DAILY.

	Dry matter.	Ash.	Protein.	Carbohydrates.	Fats.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
April 19 to 26	13.2	0.20	1.70	10.89	0.44
May 3 to 11	12.7	.20	1.42	11.04	.05
26 to 31	12.4	.16	.90	11.30	.07
June 10 to 20	7.6	.08	.53	6.9	.05

AMOUNT OF WATER DRANK DAILY.

Date.	Water.	Date.	Water.	Date.	Water.	Date	Water.	Date.	Water.	Date.	Water.
	Lbs.		Lbs.		Lbs.		Lbs.		Lbs.		Lbs.
April		May		May		June		July		July	
19	58.5	13	99	31	48	17	78	4	102	22	106.5
20	52.2	14	98	June		18	47.5	5	118	23	125.2
21	55.8	15	104	1	67.8	19	80.5	6	118	24	96.5
22	58	16	103	2	70	20	42.5	7	120.5	25	99
23	37.5	17	96.2	3	60.5	21	69.5	8	72	26	82.5
24	85.8	18	100.5	4	69	22	52	9	117.5	27	88
25	61	19	112	5	86	23	61.5	10	119	28	90.5
May		20	100	6	60	24	62	11	121.5	29	95
3	84.5	21	91	7	71.5	25	84	12	118.5	30	97
4	97.8	22	97.5	8	54.5	26	71.5	13	107.5	.....	....
5	98.5	23	84	9	49	27	81	14	69	.....	....
6	86.5	24	94.5	10	53	28	61.5	15	96	.....	....
7	91	25	86	11	58.5	29	86.5	16	136.5	.....	....
8	94.5	26	68	12	45.5	30	100	17	107.5	.....	....
9	63	27	54	13	54.5	July		18	99.5	.....	....
10	94	28	78	14	72.5	1	100.2	19	112.5	.....	....
11	98.8	29	62.5	15	53.5	2	84	20	169.5	.....	....
12	89.5	30	77.5	16	63.8	3	110	21	99.5	.....	....

BALANCE SHEET OF NITROGEN AND FAT.

Date. 1897.	Nitrogen income.	Nitrogen Outgo.				Gain of nitrogen by animal.	Loss of nitrogen by animal.	Fat income.	Fat Outgo.			Loss of fat by cow.	Weight of cow.
		Milk.	Urine.	Feces.	Total.				Milk.	Feces.	Total.		
	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams	Grams.	Grams.	Lbs.
Ration 1.—Normal Foods.													
April 19-20	186.8	47.7	75.9	68	191.6	....	4.8	287.7	455.2	82.6	537.8	250.1	....
April 20-21	186.8	45.3	76.8	57.5	179.6	7.2	....	287.7	407.2	76	483.2	195.5	868
April 21-22	186.8	47.2	74.8	66.9	188.9	....	2.1	287.7	487.5	91.5	579	291.3	867
April 22-23	186.8	47.2	75.8	55.7	178.7	8.1	....	287.7	453.5	84.4	537.9	250.2	862
April 23-24	186.8	46.0	66.3	60.2	172.5	14.3	....	287.7	428.6	77.1	505.7	218	860
April 24-25	186.8	44.9	83.1	69.3	197.3	....	10.5	287.7	394.1	92	486.1	198.4	858
pril 25-26	185.8	47.1	70.6	67.5	185.2	1.6	....	287.7	420.2	86.9	507.1	219.4	....
Total	1,307.6	325.4	523.3	445.1	1,293.8	31.2	17.4	2,013.9	3,046.3	590.5	3,636.8	1,622.9	....
Average	186.8	46.5	74.8	63.6	184.8	2.0	....	287.7	435.2	84.3	519.5	231.8	....
Ration 2.—Extracted Foods.													
April 26-27	178.9	....	....	....	....	....	....	46.7	390.3	....	....	....	....
April 27-28	193.3	47.7	....	....	....	....	....	57.4	359.1	....	....	....	....
April 28-29	193.3	47.5	....	....	....	....	....	57.4	340.4	....	....	....	....
April 29-30	193.3	45.8	....	....	....	....	....	57.4	327.4	....	....	....	....
April 30-May 1	193.3	36.5	....	....	....	....	....	57.4	239.6	....	....	....	....
May 1-2	193.3	52.6	....	....	....	....	....	57.4	544.4	....	....	....	....
May 2-3	193.3	46	....	....	....	....	....	57.4	354	....	....	....	....
May 3-4	193.3	40.1	57.5	94.4	192	1.3	....	57.4	322.1	33.7	355 8	298.4	867
May 4-5	193.3	45.1	54.2	93.1	192.4	0.9	....	57.4	295.6	31.6	327.2	269.8	866
May 5-6	193.3	46.2	59.6	99	204.8	....	11.5	57.4	332.3	32.7	365	307.6	867
May 6-7	193.3	45.5	47.5	83	176	17.3	....	57.4	331	27.1	358.1	300.7	868
May 7-8	193.3	46.4	54	90.5	190.9	2.4	....	57.4	351.5	32.4	383.9	326.5	869
May 8-9	193.3	46.1	49.5	79.8	175.4	17.9	....	57.4	353.3	28	381.3	323.9	873
May 9-10	193.3	46.4	46.6	92.7	185.7	7.6	....	57.4	360.9	31.7	392.6	337.2	872
May 10-11	193.3	45.1	61.2	90.4	196.7	....	3.4	57.4	330	32.5	362.5	305.1	870
Total	1,546.4	360.9	430.1	722.9	1,513.9	47.4	14.9	459.2	2,676.7	249.7	2,926.4	2,467.2	....
Average	193.3	45.1	53.7	90.4	189.2	5.9	1.8	57.4	334.3	31.2	365.8	308.4	....

BALANCE SHEET OF NITROGEN AND FAT — *Continued.*

Date. 1897.	Nitrogen income.	Nitrogen Outgo.				Gain	Loss	Fat income.	Fat Outgo.			Loss of fat by cow.	Weight of cow.
		Milk.	Urine.	Feces.	Total.	of nitrogen by animal.			Milk.	Feces.	Total.		
	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Lbs.
Ration 3 — Extracted Foods, Maximum Protein Supply.													
May 11-12	221.6	43.8	60.3	77.4	181.5	40.1	....	56.6	331.4	25.7	357.1	300.5	873
May 12-13	221.6	44.3	73.5	95	212.8	8.8	....	56.6	376.3	35.5	411.8	355.2	870
May 13-14	221.6	45	71.8	94.5	211.3	10.3	....	56.6	362	39	401	344.4	868
May 14-15	221.6	43.2	64.9	92.5	200.6	21	....	56.6	343.2	33.4	376.6	320	870
May 15-16	221.6	42.1	56	84.9	183	38	....	56.6	335.6	27.4	363	306.4	874
May 16-17	221.6	41.6	57.8	76.3	175.7	45.9	....	56.6	335.8	27.4	363.2	306.6	876
May 17-18	222.8	42.1	51.7	89.6	183.4	39.4	....	57.8	336.6	29.2	365.8	308	875
Total	1,552.4	302.1	436	610.2	1,348.3	201.1	....	397.4	2,420.9	217.6	2,638.5	2,241.1	....
Average	221.8	43.2	62.3	87.2	192.6	29.2	....	56.8	345.7	31.1	376.9	320.1	....
Transition Period—Protein Decreased, Carbohydrates Increased.													
May 18-19	210.4	41.3	56.3	71.2	168.8	41.6	....	58.9	340.1	23.8	363.9	305	880
May 19-20	196.8	42.2	57.3	86.8	186.3	10.5	....	59.1	314.6	27.8	342.4	283.3	882
May 20-21	184.1	42.2	51.9	86.2	180.3	3.8	....	59.6	341.5	29.5	371	311.4	884
May 21-22	171	41.8	49.3	87.7	178.8	....	7.8	60	367.8	32.8	400.6	340.6	886
May 22-23	157.9	41.1	40.3	87	168.4	....	10.5	60.4	332.2	33.1	365.3	304.9	885
Total	920.2	208.6	255.1	418.9	882.6	56.1	18.3	298	1,696.2	147	1,843.2	1,545.2	....
Average	184	41.7	51	83.8	176.5	7.5	....	59.6	339.2	29.4	386.6	309	....

BALANCE SHEET OF NITROGEN AND FAT.—*Continued.*

Date. 1897.	Nitrogen income.	Nitrogen Outgo. Milk.	Nitrogen Outgo. Urine.	Nitrogen Outgo. Feces.	Nitrogen Outgo. Total.	Gain of nitrogen by animal.	Loss of nitrogen by animal.	Fat income.	Fat Outgo. Milk.	Fat Outgo. Feces.	Fat Outgo. Total.	Loss of fat by cow.	Weight of cow.
	Grams.	Grams	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Lbs.
Ration 4.—Maximum Carbohydrates, Minimum Protein.													
May 23-24	144.8	38.8	39.2	87.4	165.4	....	20.6	60.7	309	28	337	276.3	887
May 24-25	144.8	38.4	36.9	66.5	141.8	3	....	60.7	306.1	24.4	330.5	269.8	889
May 25-26	144.8	36.5	38.9	81.9	157.3	....	12.5	60.7	298	29.1	327.1	266.4	889
May 26-27	144.8	34.1	36.8	87.2	158.1	....	13.3	60.7	255.2	24.4	284.6	223.9	890
May 27-28	144.8	35.1	31	72.6	138.7	6.1	....	60.7	339.9	24.4	364.3	303.6	865
May 28-29	144.8	34.9	28.9	86.9	150.7	....	5.9	60.7	301.6	29.2	330.8	270.1	892
May 29-30	144.8	33.8	28.4	77.8	140.0	4.8	....	60.7	280.1	29	309.1	248.4	898
May 30-31	144.8	33	27.4	74.3	134.7	10.1	....	60.7	276.2	31.8	308	247.3	884½
Total	1,158.4	281.6	267.5	634.6	1,186.7	24	52.3	485.6	2,366.1	225.3	2,591.4	2,105.8	....
Average	144.8	35.6	33.4	79.3	148.3	....	3.5	60.7	295.8	28.2	324	263.2	....
Ration 5—Two-thirds Ration 4.													
May 31-June 1	48.3	32	25.9	65.2	123.1	....	74.8	20.2	267.3	18.1	285.4	265.2	869
June 1-2	96.5	32.7	33.7	64.9	131.3	....	34.8	40.5	274.3	24.1	298.4	257.9	872
June 2-3	96.5	33.5	30.4	47.9	111.8	....	15.3	40.5	277.4	15.3	292.7	252.2	873
June 3-4	96.5	35.8	28.3	65.1	129.2	....	32.7	40.5	270.2	18.6	288.8	218.3	878
June 4-5	96.5	35.2	31.5	79.7	146.4	....	49.9	40.5	283	23.7	306.7	266.2	889
June 5-6	96.5	36.7	31	80.7	148.4	....	51.9	40.5	291	24.7	315.7	275.2	894
June 6-7	96.5	34.9	31.6	82.2	148.7	....	52.2	40.5	296.3	25.6	321.9	281.4	892
June 7-8	97.4	35.1	29.4	85.7	150.2	....	52.8	40.8	268.8	28.5	297.3	256.5	900
June 8-9	98.3	33.9	30.7	77.2	141.8	....	43.5	41.1	277.3	24.5	301.8	260.7	873
June 9-10	98.3	32.1	29.8	71.9	133.8	....	35.5	41.1	262	22.9	284.9	243.8	869
June 10-11	98.3	31.5	28.6	65.4	125.5	....	27.2	41.1	241.2	22.2	263.4	222.3	873
June 11-12	98.3	32.1	31.1	57	120.2	....	21.9	41.1	256.6	17.6	274.2	233.1	871
June 12-13	98.3	30.4	29.6	60.7	120.7	....	22.4	41.1	270.7	20.4	291.1	250	869
June 13-14	98.3	31.1	24	59.9	115	....	16.7	41.1	230.3	20.3	250.6	209.5	859
June 14-15	98.3	30.3	30	59.7	120	....	21.7	41.1	247.1	19.6	266.7	225.6	863
June 15-16	98.3	30.9	25.2	58	114.1	....	15.8	41.1	219.1	22.4	211.5	200.4	853
June 16-17	98.7	30.3	30.1	62.2	122.6	....	23.9	42.5	249.2	19.5	268.7	226.2	860
June 17-18	98.7	20.9	30.7	61.8	113.4	....	14.7	42.5	151.1	19.7	170.8	128.3	863
June 18-19	98.7	34.6	22.6	54.7	111.9	....	13.2	42.5	370	18.4	388.4	315.9	830
June 19-20	98.7	30.3	28.9	55.7	114.9	....	16.2	42.5	277.6	22.4	300	257.5	854
Total	1,905.9	641.3	583.1	1,315.6	2,543	....	637.1	802.8	5,280.5	428.5	5,709	4,906.2	....
Average	95.3	32.2	29.1	65.8	127.1	....	31.8	40.1	264	21.4	285.4	245.3	....

BALANCE SHEET OF NITROGEN AND FAT—(*Continued*).

Date. 1897.	Nitrogen income.	Nitrogen Outgo.				Gain	Loss	Fat incom	Fat Outgo.			Loss of fat by cow.	Weight of cow.
		Milk.	Uri n	Feces.	Total.	of nitrogen by animal.			Milk.	Feces.	Tota		
	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams	Grams.	Grams.	Grams.	Lbs.
Transition Period.—Nitrogen Increased.													
June 20-21	111.5	30.8	25.7	58	114.5	....	3	42	243.8	20.9	264.7	222.7	852
June 21-22	124.4	31.2	29.8	55.1	116.1	8.3	......	41.5	235.5	19.2	254.7	213.2	852
June 22-23	137.3	31.4	33.4	54.1	118.9	18.4	....	41.1	230.2	17.9	248.1	207	853
Total	373.2	93.4	88.9	167.2	349.5	26.7	3	124.6	709.5	58	767.5	642.9	....
Average	124.4	31.1	29.6	55.7	116.5	7.9		41.5	236.5	19.3	255.8	214.3	....
Ration 2.—Extracted Foods.													
June 23-24	201.2	32.5	36.6	57	126.1	75.1	....	60.9	272.9	21.2	294.1	233.2	864
June 24-25	201.2	33.8	38.8	74	146.6	54.6	....	60.9	264	22.7	286.7	225.8	858
June 25-26	192.6	36.7	39.8	79.8	156.3	36.3	....	59.1	325	32	357	297.9	886
June 26-27	192.6	37.5	44.2	91	172.7	19.9	....	59.1	339.9	28.8	368.7	309.6	893
June 27-28	193.1	39.6	45.2	89.5	174.3	18.8	....	58.6	333.5	30.8	364.3	305.7	895
June 28-29	194.2	38.4	47.4	82.4	168.2	26	....	57.9	278	31	309	251.1	897
June 29-30	194.2	40.3	51.8	88.3	180.4	13.8	....	57.9	306.7	26.8	333.5	275.6	905
June 30-July 1	194.2	39.1	53	84.3	176.4	17.3	....	57.9	314.8	30.2	345	287.1	898
Total	1,563.3	297.9	356.8	646.3	1,301	262.3	....	472.3	2,434.8	223.5	2,658.3	218.6	....
Average	195.4	37.2	44.6	80.8	162.6	32.8	....	59	304.4	37.9	332.3	273.3	....

From July 1 to July 30, Ration 2 was continued, the total income of fat being 1,829.9 grams, or 63.1 grams daily, and the milk fat being 8,392.8 grams, or 289 grams daily. During this period of 29 days the urine and feces were not collected.

NITROGEN BALANCE.

Totals by Periods.

RATIONS.	Days in period	Nitrogen Income.		Nitrogen Digested.		Nitrogen Outgo.								Nitrogen Daily.	
						Milk.		Urine.		Feces.		Totals.			
		Total.	Daily.	Total.	Daily.	Total.	Daily.	Total.	Daily.	Total.	Daily.	Total.	Daily.	Gain.	Loss.
		Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
1. Normal foods	7	1,307.6	186.8	862.5	123.2	325.4	46.5	523.3	74.8	445.1	63.6	1,293.8	184.9	2	....
2. Extracted foods	8	1,546.4	193.3	823.5	102.9	360.9	45.1	430.1	53.7	722.9	90.4	1,573.9	189.2	4.1	... ..
3. Extracted foods, more N	7	1,552.4	221.8	942.2	134.6	302.1	43.1	436	62.3	610.2	87.2	1,348.3	192.6	29.2	....
Transition period to less N	5	920.2	184	501.3	100.2	208.6	41.7	255.1	51.1	418.9	83.8	882.6	176.6	7.8	....
4. Extracted foods, less N	8	1,158 4	144.8	523.8	65.5	284.6	35.6	267.5	33.4	634.6	79.3	1,186.7	148.3	......	3.5
5. Extracted foods, min. ration	20	1,905.9	95.3	590.3	29.5	644.3	32.2	583.1	29.1	1,315.6	65.8	2,543	127.1	......	31.8
Transition period, to more N	3	373.2	124.4	206	68.7	93.4	31.1	88.9	29.6	167.2	55.7	349.5	116.4	7.9	......
2. Extracted foods	8	1,563.3	195.4	917	114.6	297.9	37.2	356.8	41.6	646.3	80.8	1,301	162.6	32.8	....
Totals while feeding extracted foods	59	9,019.8	......	4,504.1	......	2,191.8	......	2,417.5	......	4,515.7	......	9,125	......	......	....
Totals in protein equivalents	..	Lbs. 124.3	......	Lbs. 62.1	......	Lbs. 30.2	......	Lbs. 33.3	......	Lbs 62.2	......	Lbs. 125.7	......	......	....

PROTEIN BALANCE.

Daily for Periods.

RATIONS.	Days in period.	Protein daily income.	Protein digested daily.	PROTEIN DAILY OUTGO.				PROTEIN DAILY.	
				Milk.	Urine.	Feces.	Totals.	Gain.	Loss.
		Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Ration 1. Normal foods	7	2.57	1.70	0.64	1.03	0.88	2.55	0.02	....
Ration 2. Extracted foods	8	2.66	1.42	.62	.74	1.25	2.61	.05	....
Ration 3. Extracted foods, more N	7	3.06	1.85	.59	.86	1.20	2.65	.41	....
Transition period to less N	5	2.54	1.38	.57	.70	1.16	2.43	.11	....
Ration 4. Extracted foods, less N	8	2.	.90	.49	.46	1.09	2.04	......	0.01
Ration 5. Extracted, foods minimum ration	20	1.31	.41	.44	.40	.91	1.75	......	.44
Transition period to more N	3	1.71	.95	.43	.40	.77	1.60	.11	....
Ration 2. Extracted foods	8	2.69	1.58	.51	.61	1·11	2.23	.46	....

FAT BALANCE.

Totals for Periods.

RATIONS.	Days in period.	Fat Income.		Fat Digested.		Fat Outgo.						Fat Loss.	
						Milk.		Feces.		Totals.			
		Total.	Daily.	Total.	Daily.	Total.	Daily.	Total.	Daily.	Total.	Daily.	Total.	Daily.
		Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams	Grams.	Grams.	Grams.
1. Normal foods	7	2,013.9	287.7	1,422.4	203.2	3,046.3	435.2	590.5	84.3	3,636.8	519.5	1,622.9	231.8
2. Extracted foods	8	459.2	57.4	209.5	26.2	2,676.7	334.3	249.7	31.2	2,926.4	365.8	2,467.2	308.4
3. Extracted foods, more N	7	397.4	56.8	179.8	25.7	2,420.9	345.7	217.6	31.1	2,638.5	376.9	2,241.1	320.1
Transition period to less N	5	298	59.6	151	30.2	1,696.2	339.2	147	29.4	1,843.2	368.6	1,545.2	309
4. Extracted foods, less N	8	485.6	60.7	260.3	32.5	2,366.1	295.8	225.3	28.2	2,591.4	324	2,105.8	263.2
5. Extracted foods, minimum ration	20	802.8	40.1	374.3	18.7	5,280.5	264	428.5	21.4	5,709	285.4	4,906.2	245.3
Transition period to more N	3	124.6	41.5	66.6	22.2	709.5	236.5	58	19.3	767.5	255.8	642.9	214.3
2. Extracted foods	8	472.3	59	248.8	31.1	2,434.8	304.4	223.5	27.9	2,658.3	332.3	2,186	273.3
Totals in 59 days, grams	59	3,039.9	....	1,490.3	....	17,584.7	....	1,549.6	....	19,134.3	....	16,094.4	....
Totals in 59 days, lbs	....	6.7	....	3.3	....	38.8	....	3.4	....	42.2	....	35.5	....
In preliminary period, April 26–May 3	7	391.1	....	191.6	....	2,555.2	....	199.5	....	2,754.7	....	2,363.6	....
During July	29	1,829.9	....	896.6	....	8,392.8	....	933.3	....	9,326.1	....	7,496.2	....
Totals in 95 days, grams	95	5,260.9	....	2,578.5	....	28,532.7	....	2,682.4	....	31,215.1	....	25,954.2	....
Totals in 95 days, lbs		11.6	....	5.7	....	62.9	....	5.9	....	68.8	....	57.2	....

FAT BALANCE.

Daily for Periods.

RATIONS.	Days in period.	Fat income, daily.	FAT OUTGO.			Fat loss, daily.
			Milk, daily.	Feces, daily.	Total, daily.	
		Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Ration 1. Normal foods	7	0.63	0.96	0.18	1.14	0.51
Preliminary period; Ration 2	7	.12	.80	.06	.86	.74
Ration 2. Extracted foods	8	.13	.74	.07	.81	.68
Ration 3. Extracted foods	7	.13	.76	.07	.83	.70
Transition period	5	.13	.74	.07	.81	.68
Ration 4. Extracted foods	8	.13	.65	.06	.71	.58
Ration 5. Extracted foods	20	.09	.58	.05	.63	.54
Transition period	3	.09	.52	.04	.56	.47
Ration 2. Extracted foods	8	.13	.67	.06	.73	.60
Ration 2. Extracted foods	29	.14	.64	.07	.71	.57

DISCUSSION OF RESULTS.

GENERAL REMARKS.

It is proper to preface a discussion of the results of the experiment by the statement that these foods of a quite unusual character seemed to have no ill effect upon the health of the cow. Her general appearance was all that could be desired. As may be seen by the foregoing figures, the weights of water drank and of urine excreted were somewhat abnormally large, but it was not discovered that any febrile or other diseased condition existed.

The general appearance of the animal indicated a steady increase in adipose tissue throughout the experiment, except that during the feeding of Ration 5 there appeared to be no especial change. All the points by which a butcher judges the fatness of an animal indicated that at the end of the experiment the cow was in much better condition for the shambles than at the beginning. This is also shown by her generous increase in weight. Her uniformity in weight, save in a few cases where large variations were due to a failure to drink, gave to the live weights their maximum value as a guide to conclusions.

The Food Fats and Body Fats as Sources of the Milk Fats.

The results of this experiment appear to demonstrate conclusively that food fats bear no necessary relation to the formation of milk fats.

In the ninety-five days that this cow ate rations from which the fats were largely extracted, she produced 62.9 lbs. of milk fat. The quantity of fats in the food during the same time was 11.6 lbs., only 5.7 lbs. of which was digested, leaving 57.2 lbs. of milk fats in excess of the food fat supply. It is very clear that the milk fats were not taken as such from each day's rations. Could they not have come from the body fat already deposited in the animal when the experiment began? This is so highly improbable as to justify a positive negative answer. At the beginning of the ninety-five days the cow weighed 867 lbs. She was quite lean and certainly could have been no fatter than the well-fed ox which Lawes and Gilbert found to contain 7.1 per cent of fat. The total fat in her body could, therefore, scarcely have exceeded 61 lbs., and was probably less. Practically all of this possible maximum would have been required to produce the 57.2 lbs. of milk fat and it is not reasonable to suppose that the cow lost all her body fat when we see that during the period under consideration she gained 47 lbs. in live weight. There could not have been a large increase of flesh, for during 59 days of this period the nitrogen income and outgo were about evenly balanced.

It may be suggested that a change in the water of the body and in the contents of the intestines might cause large variations in body weight, which would obscure a loss of body fat. In this case, however, such a criticism would not be rational. Not only must 57.3 lbs. of fat be replaced by water or an intestinal food residue but an addition to the body weight of 47 lbs. must be accounted for in the same way, a total of 104 lbs. Such a result would have necessitated a very marked condition of emaciation and a noticeably full condition of the intestinal tract, the reverse of which was true. As before stated the cow apparently grew fat steadily during a large part of the experiment. We are therefore

impelled to the conclusion that the milk fat which this cow produced while under experimental observation had some other source than either the food fat or the previously stored body fat.

DID THIS MILK FAT COME FROM THE PROTEIN OR FROM THE CARBOHYDRATES?

In discussing this question we must confine ourselves to the data obtained for the fifty-nine consecutive days during which a record was kept of the income and outgo of both the nitrogen and fat. These data show that in this time 38.8 pounds of fat was found in the milk. If this fat was formed through the metabolism of protein, the most generally accepted theory is that urea would be a product of the chemical changes necessary to produce this result. This view being correct, the production of 38.8 pounds of fat would, according to several theorizers such as Wolff, Henneberg, Voit and Foster, require a minimum of from 75.5 to 95 pounds of protein. As a matter of fact, the nitrogen of the urine during the period under consideration was only 2,417.5 grams, equivalent to 33.3 lbs. of protein, assuming protein to be $N \times 6.25$. Osborne's and Ritthausen's results show that $N \times 6$ is probably more nearly correct, which would give 32 pounds of protein. If we adopt Henneberg's (also Wolff's) fat factor for protein, viz.: 51.4 per cent, which is the highest suggested, 33.3 lbs. of protein would furnish 17.1 lbs. of fat, leaving 21.7 lbs. to be accounted for in some other way. In this fifty-nine days the digested food fat was only 3.3 lbs. and the weight of the cow increased 33 lbs. with the nitrogen balance slightly against her body.

It is noteworthy, moreover, that during twenty consecutive days of the fifty-nine, the daily nitrogen in the cow's urine was equivalent to only 0.4 lb. of protein, while the average daily production of milk fat was 0.58 lb. Granting that none of this protein was metabolized for maintenance purposes, which is unlikely, it is of itself greatly insufficient to account for the milk fat, as it would theoretically be equivalent daily to not over 0.2 lb. of fat.

There is no way of explaining how milk fat could in any way proceed wholly from metabolized protein in this particular case, but by the improbable theory that the protein joins with other compounds in synthetical changes of which we so far have no hint.

Certainly, in this experiment, protein metabolism, as ordinarily understood, can account only for a minor part of the fat secreted in the milk, because without the aid of other compounds protein must form considerably less than its weight of fat. Some nitrogen compound must be split off which would take part of the carbon and hydrogen with it.

The only rational conclusion which these data seem to offer is that the milk fat, as previous experiments have demonstrated to be the case with body fat, was produced, in part at least, from carbohydrates. Such data do not constitute evidence that protein or food fats may not under other conditions be the source of milk fat, but only that in this experiment they were an utterly insufficient source, either directly or indirectly.

The Stimulus of Protein upon Milk Production.

If further investigations, which are now planned for the immediate future, should ratify the apparent outcome of this one, the explanation of the well-known stimulus of an abundant supply of protein upon milk secretion must rest upon some other basis than that so much protein is necessary as a source of milk building material. It is generally held, from the standpoint of both science and practice, that considerably over two pounds of digestible protein, two and one-half pounds being the amount agreed upon, should be fed in connection with a sufficient supply of carbohydrates (12½ lbs.) to a cow in the full flow of milk, if a maximum food efficiency is to be attained.

Experiments have shown that the food efficiency of a unit of digestible matter is actually augmented by increasing the proportion of protein up to approximately the quantity named, as for instance when oil meal or gluten meal is substituted for a portion of the cereal grains in a ration otherwise made up wholly of home grown foods. Surely if protein takes no necessary part,

as our results indicate, in providing raw material for the secretion of milk fat or milk sugar, a large part of this generous protein supply is not needed for constructive purposes.

When fed what is sometimes called the German balanced ration, a cow may sometimes yield thirty pounds of average milk, generally less rather than more. This milk would contain not over one pound of protein, leaving one and a half pounds or three-fifths of that in the ration unused, so far as known, for any necessary constructive purpose. We desire to propose as a rational explanation of the notable influence upon milk secretion of an abundant supply of digestible protein in the ration, that it is due to the influence of protein upon metabolic activity rather than because so much was needed from which to form milk solids. This view would not minimize our estimate of the importance of the nitrogenous constituents of cattle foods, but simply emphasizes more fully one reason, and perhaps the main one, why they should be supplied in such generous proportions.

Certain data from this experiment should be considered in this connection.

It appears that the daily digestible protein in the ration varied in the different periods between 1.85 lbs. as a maximum to 0.41 as a minimum. There was a corresponding, though not so wide, variation in the urea nitrogen, and it is interesting to note the relation between the protein supply, protein metabolism and the secretion of milk solids, as shown both by the figures and by the diagram.

RELATION BETWEEN PROTEIN SUPPLY, PROTEIN METABOLISM AND SECRETION OF MILK SOLIDS.

Digestible protein eaten daily.	Protein equivalent of urine nitrogen excreted daily.	Gain or loss of body protein daily.	Milk solids secreted daily.	Relation of protein destruction to milk solids secreted.
Lbs.	Lbs.	Lbs.	Lbs.	
1.70	1.03	+.03	2.72	100 : 2.64
1.42	.74	+.06	2.28	100 : 3.02
1.85	.86	+.41	2.22	100 : 2.59
.90	.46	—.05	1.87	100 : 4.06
.41	.40	—.44	1.67	100 : 4.19
1 58	.61	+.45	1.96	100 : 3.21

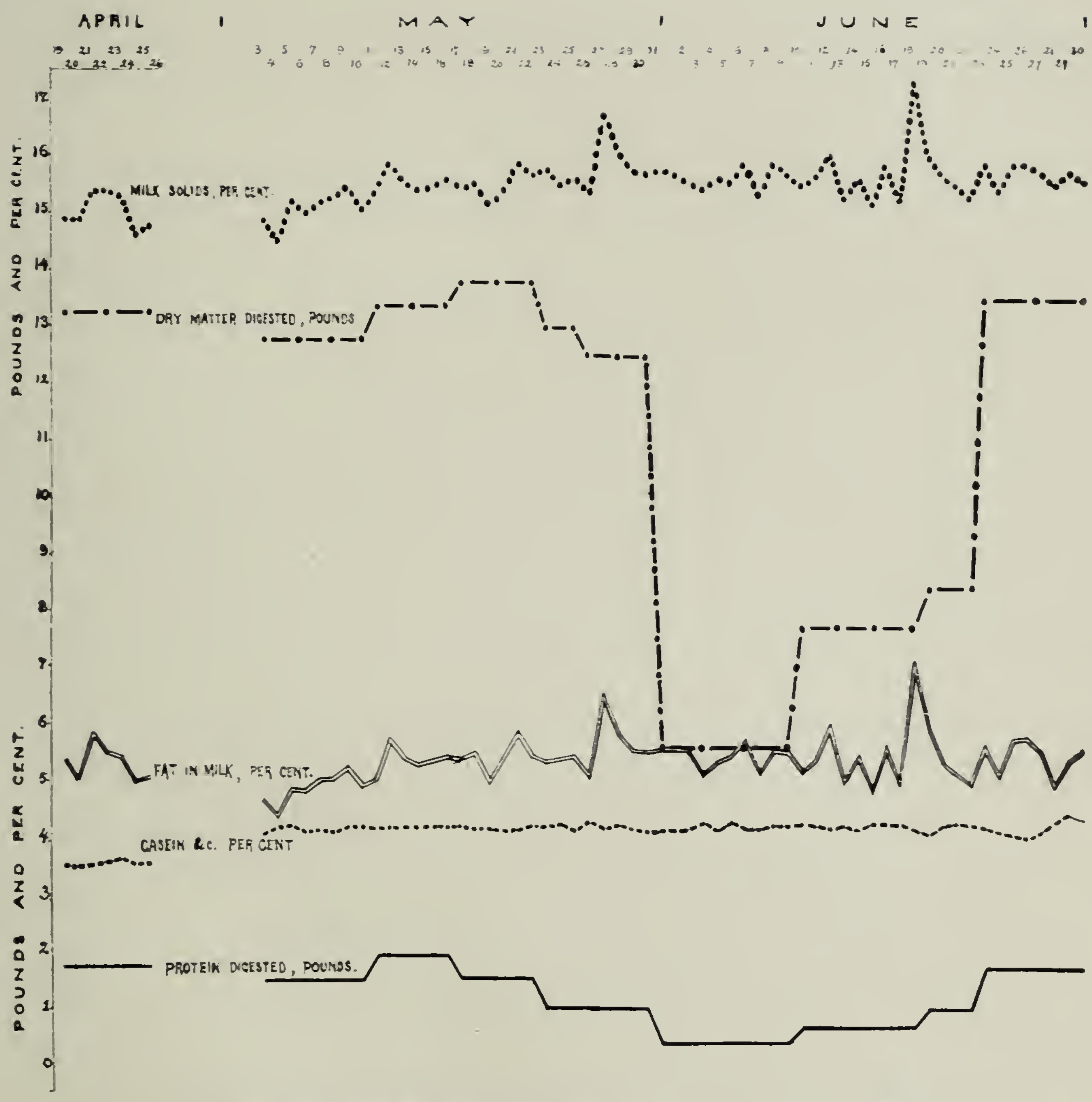


FIG. 19.—RELATION OF FOOD SUPPLY TO QUALITY OF MILK.

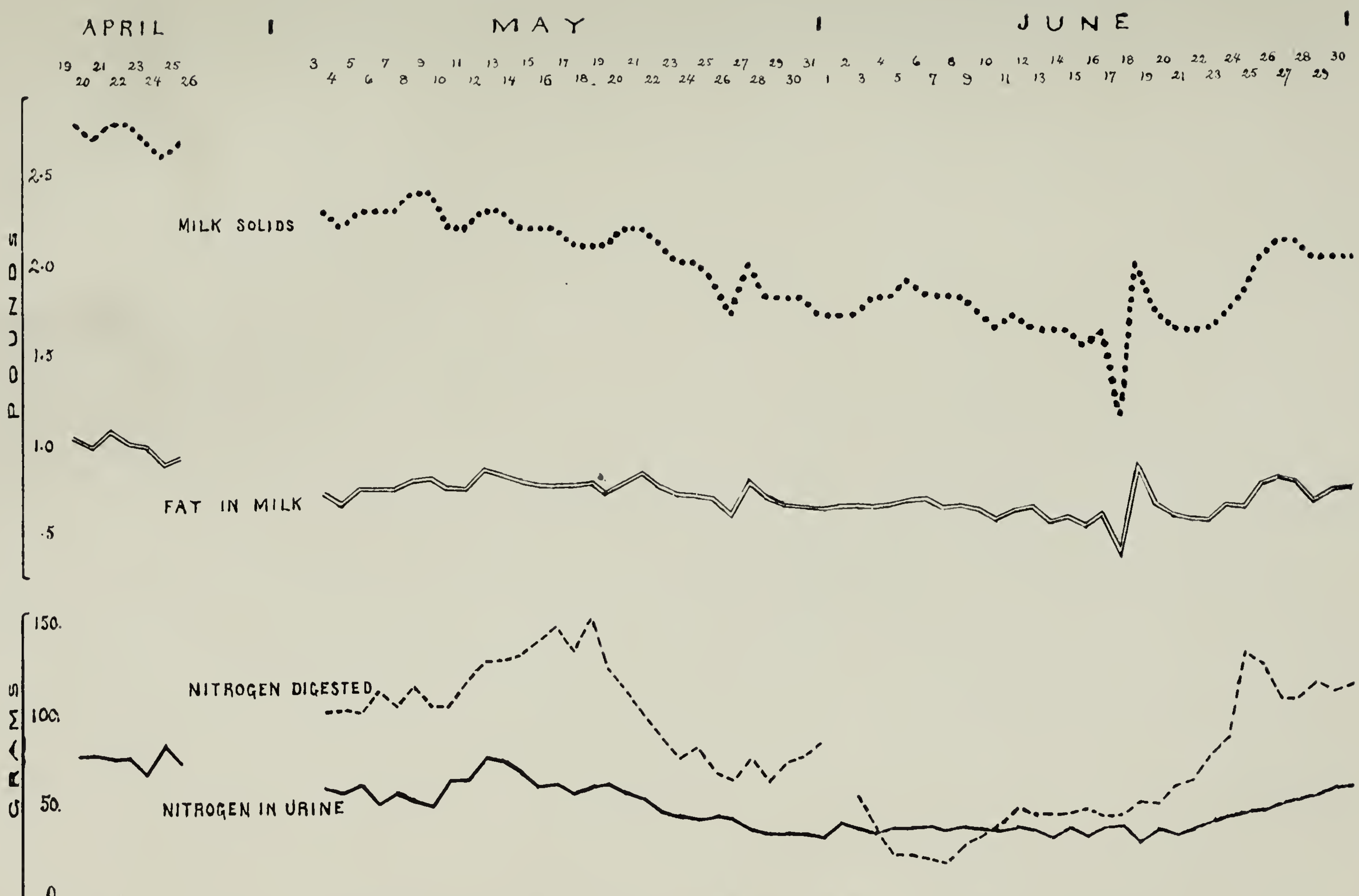


Fig. 20.—Relation of Protein Supply and Protein Metabolism to the Production of Milk Solids.

The extent of protein metabolism seems to be influenced mainly by the protein supply rather than by the quantity of milk solids secreted. When in the first periods the digestible food protein varied between 1.42 and 1.85 lbs. daily and there was an increase of body protein, the milk solids were from two and six-tenths to three times the protein equivalent of the urine nitrogen, but when the available protein in the food fell to 0.41 lbs. daily, so that the animal's needs forced a body loss of 0.44 lbs. of protein daily, the milk solids were four and two-tenths greater than the protein broken down. In view of these figures, it is not easy to avoid the conclusion that in some way the abundant metabolism induced by a generous supply of protein in the ration had a stimulative rather than a constructive (building) function in its relation to milk secretion.

The Relation Between the Food and Quality of the Milk.

The evidence on this point is incidental to the main purpose of the experiment, but is none the less emphatic.

Changes were made in the rations in three ways: (1) By decreasing the fat in the food from about the usual quantity to practically none; (2) by producing wide variations in the protein supply and nutritive ratio; and (3) by producing wide variations in the supply of total digestible material.

Were there changes in the constitution of the milk corresponding to any or all of the variations in the kind and quantity of the food supply? A careful examination of the accompanying graphic display (Fig. 19) of the amounts and kind of food eaten and of the composition of the milk, during sixty-six days, does not reveal any such relation. To be sure, when the ration was changed from the normal to the extracted foods there was quite a marked drop in the percentage of milk solids, but in a few days the milk recovered its former richness. Neither a deficiency in the protein of the ration nor a depression of the digestible nutrients to about 5.5 lbs. per day caused the cow to produce poorer milk. The only apparent effect was in changing the quantity of product. The percentages of milk solids and fat varied greatly

from day to day, usually without definite relation to any known causes. This bit of experience does not establish a law, but is in itself an event worth noting.

TOTAL MILK SOLIDS AND MILK FAT.

In this experiment the variations in milk solids were due almost wholly to changes in the percentages of milk fat. The corre sponding rise and fall of the total solids and the fat, and the uniform percentages of nitrogenous compounds are certainly remarkable and are strikingly shown in the diagramatic chart (Fig. 20). This is not a new observation, for it has been noticed repeatedly that the fat of milk is its most variable compound in percentage relations.

I. DIGESTION AND FEEDING EXPERIMENTS.*

. H. JORDAN AND C. G. JENTER.

SUMMARY.

I. The New Corn Product.

The claim that the removal of the pith from corn stover modifies the composition and increases the digestibility of the remaining portions of the stalk and leaves is not substantiated by investigations at this Station. (*a*) The pith was found to be much like the whole stover in composition. (*b*) In a trial with three sheep, corn stover with the pith was only one-half of one per cent less digestible than similar stover without the pith.

II. Actual and Calculated Digestibility.

In digestion trials with two fairly elaborate rations quite unlike in origin, the actual digestible matter closely approximated in both cases to the quantities that were calculated by the use of figures from feeding tables representing the average composition and digestion coefficients of similar materials.

III. Comparative Value of Rations from Unlike Sources.

In an extended feeding trial with two rations in which the compounds that were the source of the digestible carbohydrates were quite dissimilar, the ration containing the less fiber and a nitrogen-free extract richer in starch and sugar showed no superiority over the other. Also by-products such as malt sprouts, brewer's grains and gluten feed were successfully substituted for oats and peas.

I. THE "NEW CORN PRODUCT."

The cattle feeder is beset on every hand with new feeding stuffs—new in name if not in kind. One of the latest of these is "Marsden's Stock Food," otherwise called "A New Corn Product."

*Reprint of Bulletin No. 141.

This is a finely ground product, a refuse from the utilization of the pith of the stalk. The leaves are stripped from the stalk, the pith is removed, and the remaining portion, or the outside of the stalk, is ground into meal.

The attention of the writer was called to this food so long ago as December, 1896, through an inquiry from a correspondent of the *New York Tribune*, and in response to a request from the Agricultural Editor of that paper, the following statement was made:

"Meal which is made by grinding dry corn stalks has entirely the same food properties as the corn stalks themselves, the only possible advantage being that the animals are saved from chewing them; and also because of its fineness the meal may possibly be a little more digestible than the stover. There is no real merit in this meal which gives it any superiority over hay, corn stover or silage in so far as these latter materials are eaten and thoroughly masticated."

Since the above statement was made, this new product has received considerable attention, notably by two bulletins from the Maryland Agricultural Experiment Station* and by an article in the *Country Gentleman*† from Hon. Edward Atkinson.

The important general conclusions which Patterson draws from the Maryland Experiment Station work are that (1) the "New Corn Product" is more digestible than corn stover even if finely ground, and that (2) this product may be successfully substituted for other rough fodders and hay in a fattening ration and in feeding horses. Patterson's discussion of his data leans to the view that the presence of the pith actually depresses the digestibility of the other parts of the stover, and he offers as a reason for this the wholly hypothetical explanation that the pith so freely absorbs the digestive juices as to leave a quantity insufficient to act efficiently upon the other portions of the plant.

Atkinson discusses this new food from the economic side, but bases much of his reasoning upon what he seems to regard as two established facts, viz.: that the pith of the corn stalk is practi-

*Nos. 13 and 51.

†Issue December 16, 1897.

cally pure cellulose and that its presence depresses the digestibility of the other portions of the plant by absorbing "the saliva and the gastric juices, thus clogging the intestines ———."

All that has been said in regard to the great saving that would result from a complete utilization of the entire corn product, grain and stover, can be entirely accepted by every person well informed in cattle food matters.

The supreme importance of maize in animal husbandry and the availability and high food quality of every portion of the plant when properly harvested do not need to be established by further investigation. These are now facts of common knowledge among well-informed farmers.

Any process, therefore, which tends to a completer utilization of maize stover should be heartily welcomed. It is the opinion of the writer, however, that whatever benefit may accrue to agriculture from the Marsden process, in so far as it touches cattle feeding, will come wholly from the saving in a useful form of a valuable food material which is now largely wasted. No conclusive evidence seems to be yet secured that this "New Corn Product" possesses unusual food properties, or those which differ in any way from well cured, well prepared corn stover.

There are serious doubts whether the corn pith is so greatly unlike the remainder of the plant that its removal materially modifies the composition or digestibility of the portion that is left, and the hypothesis that this pith retards or prevents digestion by absorbing and holding the gastric juice (to say nothing of the intestinal juices) is so far too nearly guesswork to have much weight, and may be as far from the truth as the assumption that the pith is "pure" cellulose. The chances are that the "New Corn Product" is nothing more or less than *ground corn stalks* in all the essentials that pertain to digestibility and to food function or value.

This question is of sufficient importance, however, to make it desirable to secure evidence concerning the points under discussion, and for this reason this Experiment Station has been investigating the matter somewhat.

THE EXPERIMENTS AT THIS STATION.

In order to show that the removal of the pith from maize stover is beneficial from a food standpoint it must be demonstrated that the pith either contains compounds directly injurious to the animal or that in its absence the remaining portions of the plant are more fully utilized than would otherwise be the case.

Certainly the compounds in the outside stalk and leaves are not in any way changed by the presence or absence of the pith. This investigation was directed to two points, therefore, viz.: (1) the composition of maize pith as compared with the rest of the plant, and (2) the effect of removing the pith upon the digestibility of the leaves and remainder of the stalk.

THE RELATION IN WEIGHT OF DIFFERENT PARTS OF MAIZE STOVER.

About 200 lbs. of well-cured, bright corn stover, all of which came from the same lot of corn, was selected for the experiment. The leaves and husks were first stripped from one-half of each bundle and then by the use of instruments specially made for the purpose the pith was removed from the stalks.

The following are the weights of the several parts in the air dry condition:

WEIGHTS AND PROPORTION OF PARTS OF CORN STOVER.

	Weight.		Proportion.
	Grams.	Pounds	Per cent.
Leaves and husks	25,021	55.0	65.2
Stalks minus pith	9,046	20.7	24.5
Pith	3,948	8.7	10.3

It appears that the pith constituted about one-tenth of this lot of maize stover.

THE COMPOSITION OF THE STOVER AND ITS VARIOUS PARTS.

The whole stover from one-half the bundles, and the separate parts of the dissected stover were finely ground in an iron mill and from the thoroughly mixed materials samples were selected for analysis.

The composition of the whole stover, the stover without the pith and the pith are given below.

COMPOSITION OF CORN STOVER.

	Water.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
	AIR-DRY MATERIALS.					
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Whole stover	19.81	4.55	4.19	26.02	42.87	2.56
Stover without pith	12.21	4.58	4.60	28.55	47.35	2.71
Pith	13.27	3.92	3.02	29.15	45.77	4.87
	WATER-FREE MATERIALS.					
Whole stover	......	5.68	5.22	32.45	53.46	3.19
Stover without pith	......	5.22	5.24	32.52	53.93	3.09
Pith	......	4.52	3.48	33.61	52.77	5.62

It is clearly shown by these analyses that the pith of this particular lot of stover, at least, did not differ in composition to a remarkable degree from the remaining portion of the plant. It contained about two-thirds as much nitrogenous material and nearly twice as much ether extract, the proportions of fiber (crude cellulose) and nitrogen-free extract, which together make up the greater part of the stover, being very nearly the same as in the other nine-tenths of the plant. This pith, instead of being nearly pure cellulose, is at least two-thirds something else, and there is no reason for supposing that the pith of other lots of maize would be essentially unlike this sample.

It is interesting to know something of the character of the nitrogen-free extract in maize pith, as compared with the other tissue of the stover. Do the leaves and outside portion of the stalk contain a larger proportion of sugars and starch and less of those compounds concerning whose nutritive value we are less definitely informed? Actual determinations answer this question in the negative, so far as one lot of stover is concerned.

NITROGEN FREE EXTRACT IN CORN STOVER.

Laboratory number.		Calculated as Dextrose. Soluble in water.	Soluble in malt extract.	Total.
		Per cent.	Per cent.	Per cent.
58	Maize stover, whole	.82	.21	1.03
59	Maize stover, without pith	.61	.29	.90
60	Pith of maize stover	1.37	.11	1.48

This analysis of maize pith does not furnish any reason why its removal from the stover should be favorable to increased digestibility, or why the pith itself should not be nearly as digestible as the remainder of the stalk, leaves and husks.

THE COMPARATIVE DIGESTIBILITY OF MAIZE STOVER WITH AND WITHOUT THE PITH.

It was deemed essential that in order to get reliable evidence on this point the materials compared should be entirely alike in origin and treatment. The well known variations in digestibility caused with coarse fodders by the conditions of growth, the period of harvesting and the manner of curing, demand that this problem shall be studied with the use of stover from a single lot of corn, harvested at the same time and cured in the same manner. The lot of stover used satisfied all these requirements.

As before stated, the pith was removed from one-half of each bundle of stover, the other half remaining in its ordinary condition. These materials were ground in an iron feed mill, not to so fine a condition as is the case with the New Corn Product but sufficiently so to allow very thorough mixing and sampling.

Four young healthy wethers were selected for the digestion experiment. They were fed 600 grams of material daily. The preliminary period of feeding occupied eight days and the feces were collected during five days.

The composition of the stover has already been given and the other essential data are shown in the tables which follow.

COMPOSITION OF THE FECES FROM THE STOVER.

Lab. number.	SAMPLE.	AIR DRY.					
		Water.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Ether extract.
	First Period.	Per cent.	Per ct.	Per cent.	Per cent.	Per cent.	Per cent.
51	Feces from sheep No. 1.	4.96	10.80	9.62	24.62	47.96	2.04
52	Feces from sheep No. 2.	5.08	12.15	9.06	24.77	47.43	1.51
53	Feces from sheep No. 3.	4.98	12.14	8.75	23.60	48.87	1.66
54	Feces from sheep No. 4.	5.20	11.88	9.00	23.67	48.58	1.67
	Second Period.						
55	Feces from sheep No. 1.	5.09	8.35	8.94	26.85	48.86	1.91
56	Feces from sheep No. 3.	5.22	9.28	7.94	25.31	50.64	1.61
57	Feces from sheep No. 4.	5.49	9.71	9.50	24.52	48.82	1.96

DIGESTIBILITY OF CORN STOVER.

	Dry matter.	Ash.	Organic substance.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Sheep No. 1.	Grams.	Grams.	Grams.	Grams.	Grams	Grams.	Grams.
Amount fed in 5 days, 3,000 grams*	2,405.7	136.5	2,269.2	125.7	780.5	1,286.2	76.8
Amount excreted in 5 days	1,109.1	126.0	983.1	112.3	287.3	559.7	23.8
Amount digested	1,296.6	10.5	1,286.1	13.4	493.2	726.5	53.0
Per cent digested	53.9	7.7	56.7	10.7	63.2	56.5	69.0
Sheep No. 2.							
Amount fed in 5 days, 3,000 grams	2,405.7	136.5	2,269.2	125.7	780.5	1,286.2	76.8
Amount excreted in 5 days	1,091.6	139.7	951.9	104.2	284.9	545.4	17.4
Amount digested	1,314.1	....	1,317.3	21.5	495.6	740.8	59.4
Per cent digested	54.6	....	58.1	17.1	63.5	57.6	77.4
Sheep No. 3.							
Amount fed in 5 days, 3,000 grams	2,405.7	136.5	2,269.2	125.7	780.5	1,286.2	76.8
Amount excreted in 5 days	1,137.4	145.3	992.1	104.7	282.5	585.1	19.8
Amount digested	1,268.3	....	1,277.1	21.0	498.0	701.1	57.0
Per cent digested	52.7	....	56.3	16.7	63.8	54.5	74.2
Sheep No. 4.							
Amount fed in 5 days, 3,000 grams	2,405.7	136.5	2,269.2	125.7	780.5	1,286.2	76.8
Amount excreted in 5 days	1,133.3	129.5	1,003.8	98.1	258.0	529.5	18.2
Amount digested	1,272.4	7.0	1,265.4	27.6	522.5	756.7	58.6
Per cent digested	52.9	5.1	55.8	22.0	66.9	58.8	76.3
Per cent digested, averaging 4 sheep	53.5	....	56.7	16.6	64.3	56.8	76.2

* Composition given in table on page 527.

DIGESTIBILITY OF CORN STOVER WITHOUT PITH.

	Dry matter.	Ash.	Organic matter.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Sheep No. 1.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams	Grams.
Amount fed in 5 days, 3,000 grams	2633.7	137.4	2496.4	138	856.5	1420.5	81 3
Amount excreted in 5 days	1222.4	107.5	114.9	115.2	345.8	629.3	24.6
Amount digested	1411.3	29.9	1381.4	22.8	510.7	791 2	56.7
Per cent digested	53.6	21.8	55.3	16.5	59.6	55.7	69.8
Sheep No. 3.							
Amount fed in 5 days, 3,000 grams	2633.7	137.4	2496.3	138	856.5	1420.5	81.3
Amount excreted in 5 days	1183.8	115 9	1067.9	99.2	316.1	632.5	20.1
Amount digested	1449.9	21.5	1428.4	38.8	540.4	788	61.2
Per cent digested	55.1	15.6	57.2	28.1	63.1	55.5	75.3
Sheep No. 4.							
Amount fed in 5 days, 3.000 grams	2633.7	137.4	2496.3	138	856.5	1420.5	81.3
Amount excreted in 5 days	1140.7	117.2	1023.5	114.7	295.9	589.2	23.7
Amount digested	1,493	20.2	1472.8	23.3	560.6	831.3	57.6
Per cent digested	56.7	14.7	59	16.9	65.5	58.5	70.9
Per cent digested, average 3 sheep	55.1	....	57.2	20.5	62.7	56.6	72

The comparative digestibility of the stover with and without the pith is more readily seen by bringing together the coefficients showing the average results.

DIGESTIBILITY OF CORN STOVER.

	Dry matter.	Organic matter.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
	Per cent	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Stover with pith	53.5	56.7	16.6	64.3	56.8	76.2
Stover without pith	55.1	57.2	20.5	62.7	56.6	72

We do not have here any evidence that the removal of the pith of the maize plant materially increases the food value of the remaining portion. One sheep digested more from the stover containing the pith and two digested less, the average being not greatly different in the two cases.

The real test of the digestibility of a feeding stuff is the digestibility of the organic matter, because in the case of such materials as corn stover the *accidental* mineral matter is a modifying factor. One-half of one per cent more of organic matter was digested from the stover without pith than from that with pith, a difference so small as to be well within the limits of error of such work.

It is fair to observe that in Patterson's trials the stover and ground products had a similar origin only in one instance, and that in ascertaining the digestibility of the whole stover like that from which the New Corn Product was made, the coefficients obtained for dry matter differed 8.5 per cent with the two animals used, a fact which detracts somewhat from the value of the data.

II. THE CALCULATION OF THE VALUE OF RATIONS.

During the past fifteen or twenty years farmers have had their attention directed to the so-called feeding standards, which they have been urged to follow more or less closely in making up rations for various purposes. In order to ascertain whether any

given ration approximates to a desired standard it is necessary to determine the amounts and proportions of digestible nutrients which the proposed mixture of foods contains. A knowledge of the exact composition and digestibility of the feeding stuffs to be used is not possible, usually, certainly not in ordinary practice, and the computation of the amounts of digestible compounds must be based upon the average composition and digestibility of similar materials. It is assumed that figures reached in this way are sufficiently accurate for all practical purposes.

The compounding of rations from a variety of foods to correspond to certain standards, as usually done, involves another assumption, viz.: That a pound of digestible material, carbohydrates for instance, has a uniform value no matter what its source.

Probably well-informed agricultural chemists do not assent to this statement, and doubtless they are agreed that this assumption is possibly an element of weakness in the effort to compound equivalent rations from greatly different mixtures of feeding stuffs.

Much of the doubt on this point pertains to the nitrogen-free extract. Great uncertainty exists as to the relative nutritive value of the sugars, starches, pentosans, cellulose and other compounds, some of which belong to the hexose group, others to the pentose, etc. We do know, however, that there is a marked variation in the proportions in which these carbohydrates and other compounds are found in the nitrogen-free extract of feeding stuffs, especially when the coarse fodders are compared with the cereal grains.

Moreover, the protein of cattle foods is a collective name for a mixture of nitrogenous compounds and there is good reason for believing that $N \times 6.25$ does not always represent the same nutritive value, as for instance in roots, in green crops and in the oil meals.

It is proper to inquire, therefore, to what extent these possible variations of composition and food values of different com-

pounds of the same class may cause actual differences in the relative efficiency of two rations combined from unlike foods but similar in amount of digestible material and nutritive ratio when calculated on the basis of average composition and digestibility.

The writer is not aware that any comparison has so far been made of the *calculated* and the *actual* digestibility of rations, nor between the nutritive effect of the two rations with especial reference to the points which are discussed in this connection.

THE CALCULATED AND THE ACTUAL DIGESTIBILITY OF TWO RATIONS.

Two rations quite unlike in origin were selected for an experiment by this Station. In one the proportion of timothy hay was large and the grains were entirely by-products. In the other corn silage was freely used and the grains were entirely ground oats and ground peas. The hay, silage and oats were home grown and the other materials were of the usual commercial grade. Without knowing the composition of these feeding stuffs, the digestible nutrients they would supply were calculated from the averages of feeding tables.

AVERAGE COMPOSITION AND DIGESTIBILITY OF CERTAIN FEEDING STUFFS.

	Water.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.	Digestion Coefficients.† Protein.	Digestion Coefficients.† Fiber	Digestion Coefficients.† Nitrogen-free extract.	Digestion Coefficients.† Fat.
	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.				
Timothy hay*	13.2	4.4	5.9	29	45	2.5	49	53	63	57
Corn silage‡	73.6	2.1	2 7	7.8	12.9	.9	55	66	69	72
Oats*	11	3	11.8	9.5	59.7	5	78	26	77	83
Peas*	10.5	2.6	20.2	14.4	51.1	1.2	83	26	94	54
Malt sprouts*	10.2	5.7	23.2	10.7	48.5	1.7	80	33	68	100
Brewer's grains*	8.2	3.6	19.9	11	51.7	5.6	79	53	59	91
Buffalo gluten meal§	8.2	.9	23.2	6.8	49.4	11.5	85	43	81	81

* Jenkins & Winton. † American excepting those for oats. ‡ Wisconsin analyses.
§ Rep. Mass. Station, Jan., 1897.

The calculated digestible nutrients in two rations, based upon the foregoing figures would be as follows:

DIGESTIBLE NUTRIENTS IN CONTRASTED RATIONS.

	Protein.	Carbohydrates.	Fats.
Ration 1.			
	Lbs.	Lbs.	Lbs.
Five pounds timothy hay	0.14	2.18	0.07
Forty pounds corn silage	.60	5.60	.26
Five pounds ground oats	.46	2.43	.20
Six pounds ground peas	1.01	3.10	.04
Total 16.1 pounds	2.21	13.31	.57
Ration 2.			
Fifteen pounds timothy hay	0.43	6.55	0.21
Twenty-five pounds corn silage	.38	3.50	.16
Two pounds malt sprouts	.37	.73	.03
Three pounds brewer's grains	.47	1.03	.15
Three pounds Buffalo gluten feed	.59	1.29	.28
Total 16.2 pounds	2.24	13.10	.83

In the succeeding table is stated the actual composition of the feeding stuffs used in this comparison.

COMPOSITION OF FEEDING STUFFS.

Station number.		Water.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fats.
		Per cent.	Per cent.	Per cent	Per cent.	Per cent.	Per cent.
17	Timothy hay	12.63	4.09	5.49	29.18	45.33	3.28
45	Corn silage	75.27	1.25	2.27	5.34	14.04	1.83
46	Corn silage	75.85	1.23	1.99	5.80	13.31	1.82
47	Corn silage	77.20	1.13	1.81	5.73	12.21	1.92
48	Corn silage	77.32	1.02	1.82	5.39	12.62	1.83
49	Corn silage	76.97	1.04	1.81	5.54	12.73	1.91
20	Oats	10.57	2.95	12.48	10.54	58.37	5.09
50	Oats	10.48	2.57	13.06	9.79	59.10	5.00
21	Peas	11.35	2.59	23.39	5.20	56.26	1.21
16	Malt sprouts	9.58	5.34	26.18	11.05	44.52	3.33
18	Brewer's grains	7.68	2.82	27.59	13.01	40.46	8.44
19	Buffalo gluten feed	10.29	3.29	24.95	5.28	52.97	3.22

A digestion experiment with two mixtures of foods similar in kind and proportions to the rations previously given was carried on with four sheep.

CONSTITUENTS AND AMOUNTS OF RATIONS COMPARED.

	Period 1.		Period 2.	
	Full ration No. 1. Sheep 1 and 2.	Half ration No. 2. Sheep 3 and 4.	Full ration No. 2. Sheep 1 and 2.	Half ration No. 1. Sheep 3 and 4.
	Grams.	Grams.	Grams.	Grams.
Timothy hay	100	150	300	50
Corn silage	800	250	500	400
Oats, ground	100	....	....	50
Peas, ground	120	....	....	60
Malt sprouts	....	20	40	....
Brewer's grains	....	30	60	....
Buffalo gluten feed	....	30	60	....

COMPOSITION OF FECES.

Laboratory number.	SAMPLES.	Air Dry.					
		Water.	Ash.	Protein.	Fiber.	Ether extract.	Nitrogen-free extract.
	First Period.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
37	Feces from sheep No. 1...	4.26	10.48	10	25.62	3.40	46.24
38	Feces from sheep No. 2...	4.24	10.83	12.56	23.66	3.33	45.38
39	Feces from sheep No. 3...	4.19	9.74	12.31	22.90	3.70	47.16
40	Feces from sheep No. 4...	4.15	11.75	11.50	24.96	3.32	44.32
	Second Period.						
41	Feces from sheep No. 1...	4.55	10.92	11.94	24.91	3.44	44.24
42	Feces from sheep No. 2...	4.60	10.77	11.75	24.90	3.03	44.95
43	Feces from sheep No. 3...	4.21	9.31	11.32	25.41	3.58	46.17
44	Feces from sheep No. 4...	4.08	10.32	10.06	27.48	3.52	44.54

DIGESTIBILITY OF RATIONS — PERIOD I.

Laboratory number.	RATION No. 1.	Amount fed.	Dry matter.	Ash.	Organic substance.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
	Sheep No. 1.	Grams.	Grams.	Grams	Grams	Grams.	Grams.	Grams.	Grams.
17	Timothy hay fed in 5 days	500	436.8	20.4	416.4	27.5	145.9	226.6	16.4
47–48	Silage fed in 5 days	4,000	909.6	42.8	866.8	72.8	222.4	496.8	74.8
20	Oat meal fed in 5 days	500	447.1	14.7	432.4	62.4	52.7	291.9	25.4
21	Pea meal fed in 5 days	600	531.9	15.5	516.4	140.3	31.2	337.6	7.3
	Total fed in 5 days	....	2,325.4	93.4	2,232	303	452.2	1,352.9	123.9
41	Amount excreted in 5 days*	744	710.1	81.2	628.9	88.8	185.3	329.2	25.6
	Amount digested	....	1,615.3	12.2	1,603.1	214.2	266.9	1,023.7	98.3
	Per cent digested	....	69.5	13.1	71.8	70.7	59	75.7	79.3
	Sheep No. 2.								
	Total fed in 5 days	....	2,325.4	93.4	2,232	303	452.2	1,352.9	123.9
42	Amount excreted in 5 days*	747.5	713.1	80.5	632.6	87.8	186.1	336.1	22.6
	Amount digested	....	1,612.3	12.9	1,599.4	215.2	266.1	1,016.8	101.3
	Per cent digested	....	69.3	13.8	71.7	71	58.9	75.2	81.8

* Air dry.

DIGESTIBILITY OF RATIONS.—PERIOD I.—(*Concluded*).

Laboratory number.	RATION No. 2.	Amount fed.	Dry matter.	Ash.	Organic substance.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
	Sheep No. 3.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
17	Timothy hay fed in 5 days	750	655.3	30.7	624.6	41.2	218.8	340	24 6
48–49	Silage fed in 5 days	1,250	285.7	12.9	272.8	22.7	68.2	158.5	23.4
16	Malt sprouts fed in 5 days	100	90.4	5.3	85.1	26.2	11.1	44.5	3.3
18	Brewer's grains fed in 5 days	150	138.5	4.2	134.3	41.4	19.5	60.7	12.7
19	Gluten feed fed in 5 days	150	131.5	4.9	129.6	37.4	7.9	79.5	4.8
	Total fed in 5 days	....	1,304.4	58	1,246.4	168.9	325.5	683.2	68.8
43	Amount excreted in 5 days*	451.5	432.5	42	390.5	51.1	114.7	208.5	16.2
	Amount digested	....	871.9	16	855.9	117 8	210.8	474.7	52.6
	Per cent digested	....	66.9	27.6	68.7	69.8	64.8	69.5	76.5
	Sheep No. 4.								
	Total fed in 5 days	....	1,304.4	58	1,246.4	168.9	325.5	683.2	68.8
44	Amount excreted in 5 days*	475	455.6	49	406.6	47.8	130.5	211.6	16.7
	Amount digested	....	848.8	9	839.8	121.1	195	471.6	52.1
	Per cent digested	....	65.1	15.5	67.4	71.7	59.9	69	75.7

* Air dry.

DIGESTIBILITY OF RATIONS.—PERIOD I.

Labratory number.	RATION No. 2.	Amount fed.	Dry matter	Ash.	Organic substance.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
	Sheep No. 1.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
17	Timothy hay fed in 5 days	1,500	1,310.5	61.4	1,249.1	82.3	437.7	679.9	49.2
45–46	Silage fed in 5 days	2,500	611	31	580	53.2	139.2	342.1	45.5
16	Malt sprouts fed in 5 days	200	180.8	10.7	170.1	52.3	22.1	89	6 7
18	Brewer's grains fed in 5 days	300	277	8.5	268.5	82.8	39	121.4	25.3
19	Gluten feed fed in 5 days	300	269.1	9.9	259 2	74.8	15.8	158.9	9.7
	Total fed in 5 days	....	2,618.4	121.5	2,526.9	345.4	653.8	1,391.3	136.4
37	Amount excreted*	1,047	1,002.4	109.7	892.7	104.7	268.2	484.2	35.6
	Amount digested	....	1,646	11.8	1,634.2	240.7	385.6	907.1	100.8
	Per cent digested	....	62.2	9.7	64.7	69.7	59	65.2	73.9
	Sheep No. 2.								
	Total fed in 5 days	....	2,648.4	121.5	2,526.9	345.4	653.8	1,391.3	136.4
38	Amount excreted in 5 days*	1,076	1,030.3	116.5	913.8	135.1	254.6	488.3	35 8
	Amount digested	....	1,618.1	5	1,613.1	210.3	399.2	903	100.6
	Per cent digested	....	61.1	4.1	63.8	60.9	61.1	64.9	73.8

* Air dry.

DIGESTIBILITY OF RATIONS. — PERIOD I. — (*Concluded*).

Laboratory number.	RATION No. 1.	Amount fed.	Dry matter.	Ash.	Organic substance.	Protein.	Fiber.	Nitrogen-free extract	Fat.
	Sheep No. 3.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
17	Timothy hay fed in 5 days	250	218.4	10.2	208.2	13.7	72.9	113.4	8.2
46-47	Silage fed in 5 days	2,000	469.6	23.6	446	38	115.4	255.2	37.4
20	Oat meal fed in 5 days	250	223.6	7.4	216.2	31.2	26.4	145.9	12.7
21	Pea meal fed in 5 days	300	265.9	7.8	258.1	70.2	15.6	168.7	3.6
	Total fed in 5 days	....	1,177.5	49	1,128.5	153.1	230.3	683.2	61.9
39	Amount excreted*	299	286.5	29.1	257.4	36.8	68.5	141	11.1
	Amount digested	....	891	19.9	871.1	116.3	161.8	542.2	50.8
	Per cent digested	....	75.7	40.6	77.2	76	70.3	79.4	82.1
	Sheep No. 4.								
	Total fed in 5 days	....	1,177.5	49	1,128.5	153.1	230.3	683.2	61.9
40	Amount excreted in 5 days*	330.5	316.8	38.8	278	38	82.5	146.5	11
	Amount digested	....	860.7	10.2	850.5	115.1	147.8	536.7	50.9
	Per cent digested	....	73.1	20.8	75.4	75.2	64.2	78.6	82.2

* Air dry.

These coefficients can be more easily seen by bringing them together as averages.

AVERAGE DIGESTIBILITY OF RATIONS.

		Dry matter.	Ash.	Organic matter.	Protein.	Fiber.	Nitrogen-free extract	Fat.
		Per ct.	Per ct.	Per ct	Per ct.	Per ct.	Per ct.	Per ct.
Ration 1.	Full amount	69.4	13.4	71.7	70.8	59	75.4	80.5
	Half amount	74.4	30.7	76.4	75.6	67.2	79	82.1
Ration 2.	Full amount	61.6	7.9	64.2	65.3	60	65	73.8
	Half amount	66	21.5	68	70.7	62.3	69.2	76.1

THE DIGESTIBLE NUTRIENTS IN THE TWO RATIONS BASED UPON ACTUAL FEEDING TRIALS.

	TOTALS IN THE FEEDING STUFFS.				
	Organic matter.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Ration 1.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.
5 pounds timothy hay	4.16	0.27	1.46	2.27	0.16
40 pounds corn silage	8.67	.73	2.22	4.97	.75
5 pounds oats, ground	4.32	.62	.53	2 92	.25
6 pounds peas, ground	5.16	1.40	.31	3.88	.07
Totals	22.31	3.02	4.52	13.54	1.23
Coefficients of degestibility *	71.7	70 8	59	75.4	80.5
Actually digested	16	2.14	2.67	10.20	.99
Ration 2.					
15 pounds timothy hay	12.49	0.82	4.38	6.80	0.49
25 pounds corn silage	5.80	.53	1.39	3.42	.46
2 pounds malt sprouts	1.70	.52	.32	.89	.07
3 pounds brewer's grains	2.68	.83	.39	1.21	.25
3 pounds Buffalo gluten feed	2.59	.75	.15	1.59	.10
Totals	25.26	3.45	6.53	13.91	1.37
Coefficients of digestibility *	64.2	65.3	60	65	73.8
Actually digested	16.22	2.25	3.92	9.04	1.01

* Those from the "full amount."

It is now possible to compare the calculated and actual digestibility of the two rations. The first step necessary is to apply the coefficients which are found by experiments with these mixtures of foods, to the quantities of dry matter and of the several classes of ingredients actually contained in the proposed rations.

DIGESTIBLE NUTRIENTS IN TWO RATIONS AS CALCULATED AND AS ACTUALLY DETERMINED.

		Organic matter.	Protein.	Carbohydrates.	Fats.
		Lbs.	Lbs.	Lbs.	Lbs.
Ration 1.	Calculated	16.1	2.21	13.31	0.57
	Actual	16	2.14	12.89	.99
Ration 2.	Calculated	16.2	2.24	13.1	.83
	Actual	16.22	2.25	12.96	1.01

The closeness of agreement between what was actually digested from these rations and the calculated amounts is encouraging. Variations greater than those observed in these trials doubtless occur, but if the calculated and the actual digestible organic matter will agree within one-fourth or even one-half a pound, such a calculation insures much greater accuracy and certainty than could be secured by any other method.

Two events do not establish a rule but these here noted are regarded as important and significant.

The influence of the quantity of food eaten upon its digestibility.— The results of the comparison of the "full" and "half" ration show the latter to be uniformly more fully digested. This outcome conflicts with the teachings of certain former experiments. Wolff's experiments* with clover hay alone and with clover hay and roots fed to oxen and sheep appear to demonstrate that the digestibility of a ration is not influenced by its size.

Later investigation† gave the same results when lucerne hay was fed to both sheep and the horse. On the contrary Weiske‡ found that when oats were fed to dogs the digestibility was inversely proportional to the amount eaten.

In our experiment the difference between the large and small rations is too large and too uniform to be explained by errors.

* Die Ernährung.

† Landw. Versuchs Stationen, XXI, p. 20.

‡ Landw. Versuchs Stationen, LXI, p. 145.

THE RELATIVE NUTRITIVE EFFECT OF RATIONS FROM UNLIKE SOURCES.

The main reason why a unit of digestible material from unlike sources may not have a fixed food value has already been discussed, viz.: the great variations in the character of the protein and nitrogen-free extract. For instance, in the grains, the nitrogen is almost wholly albuminoid, and the nitrogen-free extract is largely starch, while in coarse fodders and roots, much of the nitrogen may come from amid compounds and the nitrogen-free extract contains a generous proportion of pentosans and other bodies not so well understood. Even among the grain foods there are important differences of this kind. Certain of the commercial feeds are residues of the manufacture of beer, glucose and starch from the cereal grains, the starch of the barley and corn having been largely extracted. This results in a concentration of the nitrogen compounds as a whole, and of the nitrogen free compounds that are not starch or sugars. May these undoubted differences have an appreciable influence upon the nutritive effect of two rations?

The two rations under discussion in this connection were selected for a feeding experiment because they illustrate the facts we are now considering. We have shown that they contain practically the same amounts of digestible material with very nearly the same nutritive ratio. The actual compounds in the two rations are in part quite unlike, however. It is well to call attention, in this connection, to the fact that the hexose sugars and the starches as found in cattle foods possess certain characteristics that distinguish them from any other of the compounds which make up the nitrogen-free extract. The sugars either require no changes through digestion in order to be directly absorbed into the circulation, or only a change from one sugar to another, while starch, through the action of diastatic ferments easily suffers complete hydrolysis to one form of sugar. In other words, these carbohydrates are readily and wholly

transformed, without waste, into a sugar which is completely absorbed into the blood. It is true at least that repeated trials have failed to reveal the presence of either sugar or starch in the fecal residue, which indicates complete solution and absorbtion. Other compounds which contribute to the so-called digestible carbohydrates, such as cellulose and pentosans are digested in part only, and we are not able to declare whether that which is digested serves the purposes of nutrition as efficiently as the hexose sugars and the starches. The writer has been inclined to regard the high comparative value of grain foods as partly explained by the kind and not wholly by the proportion, of compounds digested.

The percentage of total sugars and starches was determined in the several materials that were used in compounding the two rations previously given. All the carbohydrates soluble in an extract of malted barley grains were assumed to belong to these compounds in Rations 1 and 2.

THE STARCH AND SUGAR IN CERTAIN FEEDING STUFFS.

Laboratory number.		In Water-Free Materials.			Per cent nitrogen free extract not starch and sugar.
		Total nitrogen-free extract.	Soluble in malt extract.	Insoluble in malt extract.	
		Per cent.	Per cent.	Per cent.	Per cent.
17	Timothy hay	51.9	15.7	36.2	70
45–49	Corn silage	55.3	26.4	28.9	52.3
20	Oats	65.3	50.3	15	23
21	Peas	63.5	53.9	9.6	15.1
16	Malt sprouts	49.2	22.9	26.3	55.5
18	Brewer's grains	43.8	12.9	30.9	70.5
19	Buffalo gluten feed	59	37.1	21.9	37.1

After having carried our analyses to this point it is possible to calculate the amounts of these two classes of nitrogen-free compounds in Rations 1 and 2.

Starch and Sugar in Rations Compared.

	Amount fed.	Dry matter fed.	Percentage of starch and sugar.	Amount starch and sugar fed.
Ration No. 1.				
	Pounds.	Pounds.	Pounds.	Pounds.
Timothy hay	5	4.4	15.7	0.69
Corn silage...............	40	9.1	26.4	2.40
Oats, ground	5	4.5	50.3	2.26
Peas, ground	6	5.3	53.9	2.86
Total	....	23.3	....	8.21
Ration No. 2.				
Timothy hay	15	13.1	15.7	2.05
Corn silage...............	25	6.1	26.4	1.61
Malt sprouts...............	2	1.8	22.9	.41
Brewer's grains	3	2.8	12.9	.36
Buffalo gluten feed	3	2.7	37.1	1
Total	....	26.5	....	5.43

The data here recorded show that the nitrogen-free dry matter in these rations, exclusive of ash and fat, was made up as follows:

Nitrogen-Free Matter in Rations.

	Ration 1. Lbs.	Ration 2. Lbs.
Starch and sugar................................	8.21	5.43
Other nitrogen-free extracts..........................	5.33	8.48
Fiber	4.52	6.53
Total fed................................	18.06	20.44

The digestible "carbohydrates" had three sources.*

Digestible Carbohydrates in Rations.

	Ration 1. Lbs.	Ration 2. Lbs.
From starch and sugar..............................	8.21	5.43
From other nitrogen-free extract....................	1.99	3.61
From fiber	2.67	3.92
Total digested...............................	12.87	12.96

* See also results of digestion experiments, p. 540.

It appears that in Ration No. 1, 64 per cent, and in Ration No. 2, 42 per cent of the digested "carbohydrates" consisted of starch and sugar.

Of the nitrogen-free extract not starch and sugar, 37 per cent and 42 per cent were digested in the two cases, the amount being nearly twice as much in Ration No. 2 as in No. 1. In Ration No. 1, 20.7 per cent and in Ration No. 2, 30.2 per cent of the digestible carbohydrates came from the fiber. From a theoretical point of view, when we consider that the pentose sugars formed may be less assimilable than the hexose, and that cellulose digestion may in part be due to destructive fermentations, it is reasonable to admit the possibility of unlike nutritive values for a unit of digestible material from these two sources; but the demonstration of this fact, if it be a fact, is a difficult matter, and must be secured through some kind of experiments with animals. A large difference in the value of two rations may be shown, perhaps, by ordinary feeding trials, but small differences may be obscured by the errors to which such experiments are subjected. The experiment subsequently described should not be regarded, therefore, as furnishing evidence of the highest character. This experiment was planned because of a desire to learn whether the milk-producing capacity of a ration is modified by the sources of the digestible compounds, other conditions being uniform.

The Experiment.

Rations similar to Nos. 1 and 2 in the kinds and proportions of fodders and grains were used in an experiment with ten cows selected from the Station herd. Some of the animals were in the early stages of lactation, and none of them were so far advanced as to endanger the reliability of the data.

They were not all fed the same quantity of food, but the weight of the ration varied with the appetite, size and production of the several cows.

The preliminary feeding began February 25 and the experiment was concluded on May 10. This time was divided into two periods, and the ten cows into two lots. During the first period Lot 1 was fed Ration No. 1 and Lot 2 Ration No. 2. In the second period this order was reversed. All the necessary data were recorded, such as the weights of foods, the weights of the animals and the weight and composition of the milk. The composition of the foods and the digestibility of the rations have been stated on previous pages.

The maximum rations fed were those previously given:

CONSTITUENTS AND AMOUNTS OF RATIONS COMPARED.

	Ration No. 1.	Ration No. 2.
Timothy hay	5 pounds.	15 pounds.
Corn silage	40 pounds.	25 pounds.
Oats, ground	5 pounds.	
Peas, ground	6 pounds.	
Malt sprouts, dried		2 pounds.
Brewer's grains, dried		3 pounds.
Buffalo gluten feed		3 pounds.

These rations, as before stated, were modified in quantity to suit the needs of the different animals, the proportions of the several materials being maintained unchanged.

Without stating the data in full detail, we give herewith the important part in a condensed form, showing the amount of each food and of the digestible matter which each cow ate and the yields of milk and milk solids.

QUANTITIES OF FOOD EATEN.

	Weights of cows.	Food Eaten.		
		Silage.	Hay.	Grain.
First period—30 days, March 2 to April 1.				
Ration 1—Lot 1.	Lbs.	Lbs.	Lbs	Lbs.
Neth. Constance	1,072	1,087.4	146.8	330
Rachel	1,068	1,080	134	300
Myra	965	1,074.7	133.5	330
Manton Belle	1,057	1,200	150	300
Barbara Allen	1,032	1,045.7	129.9	291
Ration 2—Lot 2.				
Beauty Pledge	1,101	750	447.9	240
Betsey 10th	1,320	647.7	392.5	210
Dinah	924	674.9	360.7	202.3
Junietta Peerless	964	748.5	442.3	221.2
Countess Flavia	814	517.3	317.7	176.7
Second period—33 days, April 8 to May 10.				
Ration 2—Lot 1.				
Neth. Constance	1,090	772.6	426	214.1
Rachel	1,117	742.5	425.2	231
Myra	977	741.8	297.9	226.1
Manton Belle	1,098	825	493.3	263.9
Barbara Allen	1,081	735.7	392.8	203.2
Ration 1—Lot 2.				
Beauty Pledge	1,095	1,320	165	361.5
Betsey 10th	1,324	1,184.5	147.3	330
Dinah	919	1,183.6	140.1	260.7
Junietta Peerless	975	1,318.3	163.7	352.1
Countess Flavia	825	988.5	125.3	277.2

DIGESTIBLE MATTER EATEN.

	Digestable Food Eaten.				Milk Yield.	
	Protein.	Carbo-hydrates.	Fat.	Total.	Milk.	Milk solids.
First period—30 days, March 2 to April 1.						
Ration 1—Lot 1.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.
Neth. Constance..........	67.8	375	31.4	474.2	1009.6	109.6
Rachel....................	63.2	353.3	30.2	446.7	425.1	57
Myra......................	63	352.5	30.1	445.6	446.5	63.5
Manton Belle..............	69.8	391.9	33.5	495.2	939.8	113.8
Barbara Allen.............	61.2	342.6	29.2	433	418.3	60
Ration 2—Lot 2.						
Beauty Pledge.............	72.5	377	32.3	481.8	1071.8	118.3
Betsey 10th...............	63.8	332.4	28.6	424.8	393	55.1
Dinah.....................	61.1	315.3	27.5	403.9	477 5	70.7
Junietta Peerless.........	69.1	367.6	31.4	468.1	816.1	102.2
Countess Flavia...........	52.8	271.6	23.4	347.8	605.8	86.3
Second period—33 days, April 8 to May 10.						
Ration 2—Lot 1.						
Neth. Constance..........	60.7	363.1	41.6	465.4	1054.7	117.5
Rachel....................	63.1	364.7	41.7	469.5	424	54.9
Myra......................	58.3	308.3	35.2	401.8	481	68.2
Manton Belle..............	72.1	416.7	47.7	536.5	999.9	124.3
Barbara Allen.............	57.3	339.9	39	436.2	446.9	64
Ration 1—Lot 2.						
Beauty Pledge.............	72.3	450.2	40.2	562.7	1125.5	126.5
Betsey 10th...............	65.7	406.2	36.1	508	389.3	55.2
Dinah.....................	56.4	369.7	34.1	460.2	512.2	76.4
Junietta Peerless.........	71.2	444.9	39.8	555.9	849	115.9
Countess Flavia...........	55.2	340.9	30.3	426.4	581.9	87.1
Daily average, Ration 1..	2.05	12.15	1.06	......	....	......
Daily average, Ration 2..	2	10.97	1.11	......	....	......

Digestible Matter Eaten and Milk Solids Produced.

	Ration 1.		Ration 2.	
	Digestible matter eaten.	Milk solids produced.	Digestible matter eaten.	Milk solids produced.
	Pounds.	Pounds.	Pounds.	Pounds.
	30 days		33 days	
Neth. Constance	474.2	109.6	465.4	117.5
Rachel	446.7	57	469.5	54.9
Myra	445.6	63.5	401.8	68.2
Manton Belle	495.2	113.8	536.5	124.3
Barbara Allen	433	60	436.2	64
	33 days		30 days	
Beauty Pledge	562.7	126.5	481.8	118.3
Betsey 10th	508	55.2	424.8	55.1
Dinah	460.2	76.4	403.9	70.7
Junietta Peerless	555.9	115.9	468.1	102.2
Countess Flavia	426.4	87.1	347.8	86.3
Totals, 5 cows in 63 days	4,807.9	865	4,435.8	861.5
Daily average, 1 cow	15.26	2.74	14.08	2.73
Digestible nutrients for 1 lb. milk solids.	5.56		5.15	

The results of this experiment furnish no testimony in favor of the superior quality of Ration No. 1, i. e., in favor of the ration containing the larger proportion of easily digestible carbohydrates that belong to the hexose group.

The evidence, if literally applied, shows Ration No. 2 to be even the better one. The daily production of milk solids was essentially the same with the two rations, viz.: 2.74 lbs., but the daily consumption of digestible nutrients was greater with Ration No. 1, the respective quantities being 15.3 lbs. and 14.1 lbs. and the amounts of digestible material eaten for each pound of milk solids produced were 5.56 lbs. and 5.15 lbs. If, therefore, a certain class of carbohydrate compounds possesses a superior nutritive value the fact must be brought to light through some method of investigation more searching than feeding experiments of this character.

This experiment does bear testimony concerning one matter of considerable importance. It is certainly clearly shown that in one case at least, the commercial feeding stuffs of the by-product class were successfully substituted for such grains of high quality as oats and peas.

Moreover, a much larger percentage of the digestible dry matter of the ration was supplied in timothy hay and silage in Ration 2 than in Ration 1, the proportion being about 70:55 in the two cases, but as has been stated, no evidence appeared that Ration 2 was inferior to the other. Such an outcome is encouraging to those farmers who wish to avoid the purchase of cattle foods by feeding largely of home-grown fodders and purchasing sparingly of such grains as are best calculated to supplement hay and silage.

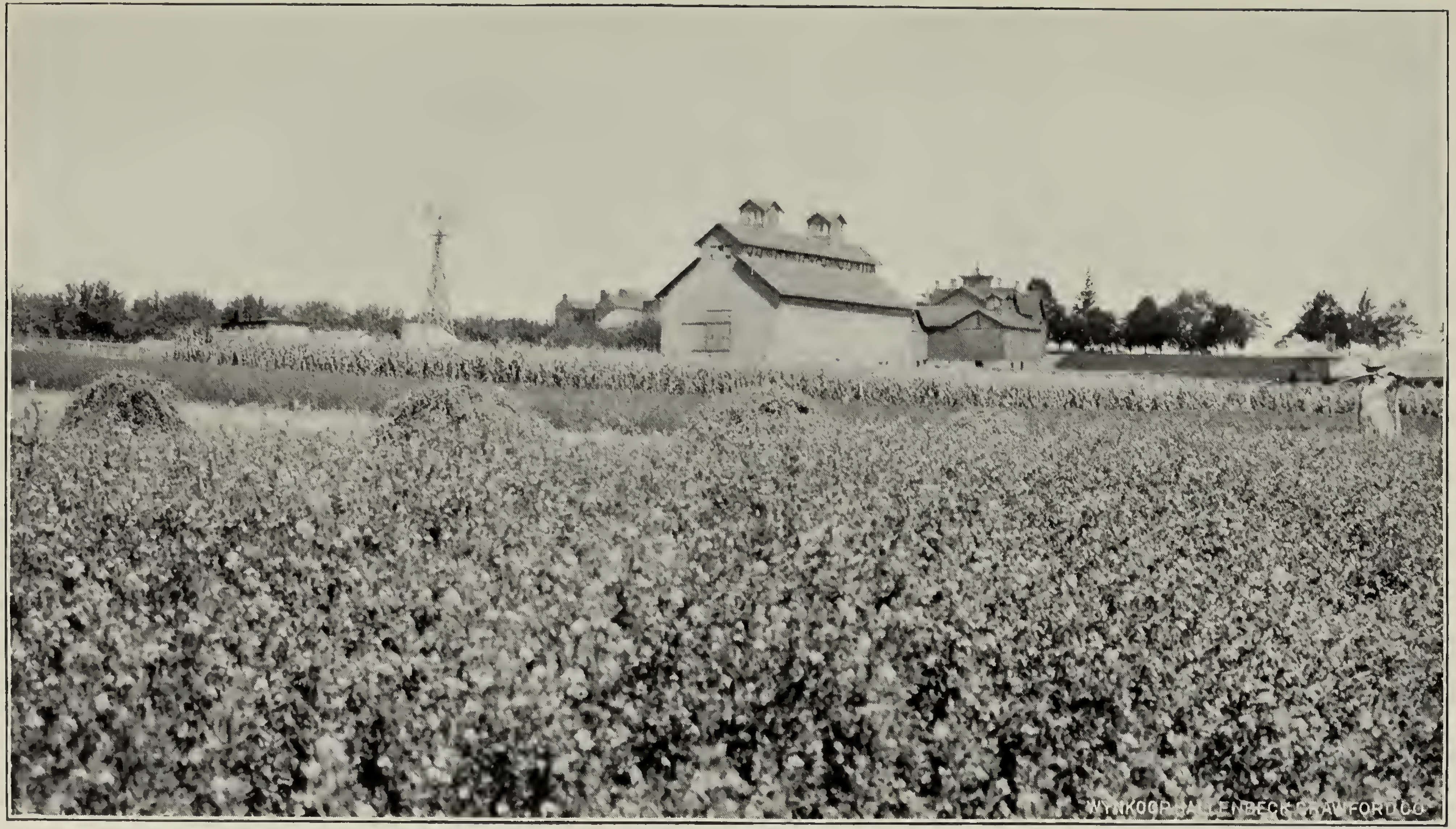


PLATE XXIX.—STATION ALFALFA FIELD, AUGUST 16, 1896; SHOWING THE THIRD CROP OF THE SEASON. THE THREE CROPS AGGREGATED OVER 15.5 TONS OF GREEN FODDER PER ACRE. SEEDED, 1893.

REPORT OF THE DEPARTMENT OF ANIMAL HUSBANDRY.

PART II.

I. ALFALFA.*

W. P. WHEELER.

SUMMARY.

Alfalfa is not suited to all kinds of soils, and is probably not hardy much north of the central portion of this State. It is, however, a plant of such decided value that it is well worth a trial in any locality where there is a fair prospect of its growing.

ALFALFA.

Since the publication of a bulletin in November, 1894, in which were stated results accompanying the feeding of alfalfa at this Station, this fodder has constituted during two more summers a larger or smaller part of the rations for milch cows. The favorable opinion then expressed concerning alfalfa has been strengthened by the further experience. Many rations containing this fodder have been as efficient and economical as those used in the fourteen feeding trials reported in the bulletin, and the good crops obtained each year warrant a recommendation of its more general trial.

The chief value of alfalfa for this State lies in its excellence as a soiling crop. In palatability it ranks high, and is not inferior in this respect to corn. It is readily eaten by all farm

*Reprint of Bulletin No. 118.

stock. Three or more cuttings can be had in a season. It furnishes a fodder rich in nitrogenous matter, and is well constituted to supplement our great fodder crop, Indian corn, which is, both in the grain and entire plant, somewhat lacking in this essential class of constitutents.

Alfalfa has proved a reliable crop at this Station for several years, although on soil apparently not best suited to it, and, while not hardy enough to endure the winters of some portions of the State, it has never been winter-killed here except on small areas where water remained on the surface over little depressions of the field.

History.

This plant, under the name of lucerne, is said to have been introduced into New York State nearly eighty years ago, but its value was apparently recognized by very few until alfalfa, which was brought into California from South America thirty years later, proved such a marked success in the West. Possibly this was because the alfalfa, early taken to Mexico, from there carried to western South America, finally to California, and from there elsewhere, became more thoroughly acclimated; for the alfalfa from the West is said to be hardier and to grow larger than the lucerne from Europe.

Alfalfa, or lucerne (*Medicago sativa*), is probably a native of the valleys of western central Asia, and has been in cultivation for a long time. It was introduced into Greece by the Persians in 490 B. C. It was highly esteemed and largely grown by the Romans, and later cultivated by the natives of southern Europe. It was, in the time of the conquest, carried by the Spaniards into Mexico under the Arabic name of alfalfa, the one then commonly used in Spain.

Characteristics.

Alfalfa is a perennial—the root living many years. The annual upright and branching stems when cut do not sprout, but die back to the crown, where new shoots start and grow rapidly. The roots extend much deeper than those of most plants, and alfalfa is, therefore, not obliged to feed altogether

near the surface. In fact, although nodules or excrescences caused by the micro-organisms are common on the roots near the surface, there are few of the small fibrous roots except at the greater depths reached, where they are abundant. This indicates a power of deep feeding. At the same time alfalfa responds readily to a top dressing of fertilizers, and abundant rainfall or surface irrigation is necessary to assure the largest crops. Old plants, will, however, make a fair growth in times of drought seriously affecting many crops. The normal root seems to be a single long tap root running to the depth of three or more feet before dividing into branches which run to greater depths of even twelve feet or more, although they will not extend below the permanent water table, nor more than a few inches into the permanently saturated soil.

Alfalfa is often able to adapt itself to soils where the roots cannot extend deeply, and plants transplanted when young, off which the tap roots have been cut at the depth of less than a foot, have endured well.

Under favorable conditions the yield of alfalfa increases up to three or four years, and good crops follow for ten years or more. Often, however, such grasses as quack and June grass, and plantains, dandelion and similar weeds spread over the field to the increasing injury of the crop, although many weeds are subdued by the frequent cuttings. Ordinarily it will pay to plow up the field after about six or eight years. Sometimes the alfalfa appears able to hold its own indefinitely. A small plat seeded to alfalfa about twelve years ago still gives two or three good cuttings each season, although it has been densly overgrown with grass for several years, and probably for the whole time. There was never more than a very scattering stand, but there appears no decrease in the number of plants.

AVERAGE YIELD.

The average of five crops of four cuttings each obtained at this Station during the three past years was over seventeen tons of green fodder per acre. This was from fields one to three years old.

CROPS IN DIFFERENT YEARS.

There was cut in 1894, from a field of 2.3 acres seeded in 1890, a total per acre of 28,085 pounds green fodder. The total dry matter was 7,406 pounds, containing 1,119 pounds of protein, of which the albuminoids constituted 899 pounds. The first cutting was in June, beginning on the 1st, the second was begun July 28th, the third September 8th, and the fourth October 15th. The first crop was a very heavy one, the second much lighter, and the last two were very light. The season was very dry.

There was cut in 1894, from a field of 1.3 acres, seeded in 1893, a total of 33,803 pounds. The dry matter was 8,116 pounds, containing 1,660 pounds of protein, of which the albuminoids constituted 1,278 pounds. The first cutting was in May, commencing on the 11th. The second cutting begun July 9th, after very dry weather; the third begun September 1st, after severe drought, and the fourth on October 18th.

There was cut in 1895 from the field of 1.3 acres seeded in 1893, a total of 37,129 pounds. The dry matter was 8,666 pounds, containing 1,452 pounds of protein, of which the albuminoids constituted 1,120 pounds. The first cutting began May 15th, the second June 15th, the third July 30th, and the fourth on September 9th. The last crop was light, and others all good.

There was cut in 1896, from the field of 1.3 acres, seeded in 1893, a total of 34,991 pounds. The dry matter in the crop was 8,527 pounds, containing 1,522 pounds of protein, of which the albuminoids constituted 1,167 pounds. The first cutting began May 27th, the second June 29th, the third August 13th, and the fourth on October 1st. The last crop was light, the others all good, the first and third being the heaviest.

There was cut in 1896, from a field of about one and one-quarter acres, seeded in 1895, a total of 36,514 pounds. The dry matter in the crop was 7,461 pounds, containing 1,302 pounds of protein, of which the albuminoids constituted 1,054 pounds. The first cutting began May 12th, the second June 13th, the third July 22d, and the fourth September 8th. The second crop was the lightest, although containing more dry matter than the last. All were good.

Occasionally, when conditions are favorable, quite a crop can be cut the same season the seed is sown. In 1895 there was cut from a field of about one and one-quarter acres, seeded in the spring, a total of 13,558 pounds. The dry matter was 3,330 pounds, containing 548 pounds of protein, of which the albuminoids constituted 416 pounds. The field was cut twice. The first cutting began July 9th, and the second August 26th.

FOOD VALUE OF SEVERAL FODDER CROPS.

In order to show the high feeding value of the alfalfa from an acre, the average product obtained at this Station during the three years past is stated in the following table in comparison with the food supplied by several of our best common fooder crops. The average of the five alfalfa crops was 34,104 pounds of green fodder, or 8,035 pounds of dry matter, containing 1,411 pounds of protein, 1,103 pounds of this being albuminoids.

FOOD VALUE OF FODDER CROPS.

	Yield per acre of total crop.	Dry matter per acre.	Total digestible matter per acre.	Digestible protein.
	Pounds.	Pounds.	Pounds.	Pounds.
Alfalfa	34,100	8,000	5,280	875
Corn, entire plant	28,000	5,800	3,800	300
Red clover	18,000	5,220	3,200	491
Oats and peas	13,000	3,120	2,521	350
Timothy	10,000	3,500	2,000	228
Rutabagas	31,700	3,400	3,000	279
Mangels	25,000	3,500	2,750	232
Sugar beets	17,800	2,500	1,800	213

The acreage yields of the several crops given above are such as have been secured at different places in this part of the country from Pennsylvania to Canada. Sometimes considerably larger crops have been obtained, but the average crop would be less than any mentioned in the table.

COMPOSITION OF THE FRESH FODDER.

The average composition of twenty lots of fresh alfalfa fodder fed at this station during the last four seasons is stated below. Corn is probably our best all around forage crop, and for com-

parison the average composition of the mature fresh corn fodder fed during the last three seasons is also stated.

	Alfalfa	Corn.
Moisture, per cent	75.6	73
Ash, per cent	2.1	1.2
Crude protein, per cent	4.4	2.3
Albuminoids, per cent	3.4	2
Crude fibre, per cent	6.5	5.3
Nitrogen-free extract, per cent	10.1	17.1
Crude fats (ether extract), per cent	1.3	1.1

SOIL.

Alfalfa grows well on varying kinds of soils, provided the subsoil is open and porous. The most favorable soil is a rich, somewhat sandy loam, warm and friable, with a deep and loose or gravelly subsoil, well supplied with lime. A dense clay or hardpan subsoil is most unfavorable. Although a rich soil is of course the best and gives the largest crops alfalfa sometimes does unexpectedly well on poor, gravelly land.

The plant consumes much water, but will not survive long in a saturated or flooded soil, and much water in or on the ground during winter is fatal. If water stands for any considerable time within a few feet of the surface the crop will be injured.

FOOD FOR THE PLANT.

An abundance of lime in the soil is especially desirable, and much iron is injurious. The plant is a heavy feeder and will not be productive on soils deficient in plant food. It is a leguminous plant and can obtain nitrogen not available to many plants, although it responds quickly to applications of nitrogenous manures. The extent of its power to obtain atmospheric nitrogen is not certain, but it is important to utilize it so far as possible and feed the crop mainly potash and phosphoric acid.

IMPROVEMENT OF SOIL.

Although so rank a feeder and large producer alfalfa is less exhaustive to the soil than many plants of lighter producing power. Where the crop is fed on the farm, as it should be, and

the manure returned to the land, there is a very noticeable increase of fertility, which may be made more permanent by moderate applications of potash salts and phosphatic fertilizers, which are well paid for by the increased yield.

In the west the great improvement in fields where alfalfa has been grown is a commonly recognized fact, although the crop is not always fed on the field. Improvement, however, cannot be lasting when plant food is continually removed. Much of the plant food left in the soil has been brought from an unusual depth. The stubble and roots of manure growth contain, on an acre, of the essential fertilizing constituents, an amount that would require about thirty-five dollars to purchase. The mechanical condition of the soil is also left improved when an alfalfa field is broken up. A crop of alfalfa virtually deepens the soil and extends the feeding ground of subsequent crops.

Seeding.

The seed should not be sown unless the soil has received careful thorough preparation, for it is very important to secure a full and uniform stand, especially if hay is to be made. The seed should be sown in the spring, after danger of severe frost is passed, and when the ground would be considered in the best possible condition for planting garden seeds. The treatment of the field for the preceding season should have been such as to have most effectually subdued all weeds, and caused the sprouting and destruction of any seed in the ground. The seed should not be sown with grain, but alone, although a good catch is sometimes secured when sown with oats, only about half the usual quantity of grain being used. If sown with grain the young plants are likely to be killed by the sun after the grain is cut.

It is best to sow about thirty pounds of seed per acre to insure a full stand. Some consider twenty pounds of seed ample. If the seeds were evenly distributed, and all would germinate and grow there would be several times the number of seeds necessary in this smaller quantity to produce a thick stand. But all conditions of soil, moisture and seed cannot always be

favorable, and it is well to sow liberally. An uneven stand is very unsatisfactory. An even stand, where the plants are several inches apart, will give as large a crop as a much thicker stand, but generally where hay is made, a thick stand is desired.

The seed should be covered, but the covering of soil should be as thin as possible, except on very light soils in a dry time. Although several methods of sowing the seed have given good results at this Station, the method usually followed has been to sow the seed broadcast and follow with a very light or brush harrow. Sometimes a very successful method is to drill in the seed and harrow very lightly across the drill marks. Sometimes simply rolling after broadcast sowing is desirable.

It will not pay to sow late in the summer. June sowing is perhaps as late as should be risked. The young plants are hardly able to endure the winter until they have had several months growth, although mature plants appear able to withstand very cold weather if the soil is not wet. The first winter is the hardest.

Seed.

Pure seed is essential. Only bright, plump, clean seeds should be sown, for shrunken seeds may produce weak and worthless plants. The seed resembles that of red clover, but is larger. Fresh seed has a greenish-yellow color, but after it has been kept in the light for a time it becomes reddish brown. Good seed retains its vitality several years if kept under favorable conditions.

The presence of the seed of narrow leaf plantain it is of vital importance to avoid. This is a long brownish seed, like a diminutive date seed, and is easily detected without the aid of a glass by any one familiar with it.

Early Treatment.

In order to check the growth of weeds a mowing machine can be run over the field of young alfalfa with the cutting-bar raised to avoid cutting near the crowns of the young plants. If the clipping is not too heavy it can be left on the field, and will serve

as a mulch during the dry weather. On rich soil sometimes two crops can be secured the first summer, but on poor soil, or in a dry season, no crop can be expected until the second year.

Established Fields.

Alfalfa should be cut every time it begins to blossom, whether the growth is short or tall, unless a seed crop is desired. The second crop of the season is better for seed than the first, probably on account of the greater number of insects that assist in fertilizing the blossoms.

The chief value of alfalfa, before stated, is as a soiling crop to be cut and fed fresh. From a field in area suited to the number of animals to be fed, there can be obtained a fairly regular succession of cuttings of green fodder. By cutting each day across the field there will be, by the time the field is cut over, a new growth where the first cutting was made. The field that will produce ample fodder during the dry weather of late summer will yield an excess during the more favorable weather of spring. This surplus can be made into hay—for the crop should always be cut when the purple blossoms show. The first crop of the season will, as a rule, prove much the heaviest if allowed to reach full development, the later cuttings being light. For this reason it may often be found preferable to begin the first cuttings when the fodder is rather imature, in this locality early in May.

Pasturage.

Alfalfa is not a safe pasturage for cattle and sheep, for it is liable to cause bloat. Where cattle and sheep are allowed to eat all they will, the fodder should be allowed to wilt before it is fed. Horses and pigs can be pastured on alfalfa, but by pasturing heavy animals, many of the crowns are broken by the hoofs and the plants are injured. Sheep cut off the crowns too close to the ground. When used to supplement dry pastures it is best to cut the fodder and carry it, when wilted, to the nearest place where it can be fed.

SILAGE.

Alfalfa silage compares well in chemical composition with clover and similar forms of silage. It is said to usually have a disagreeable odor and taste, although it is freely eaten by cattle. No experiments in the use of alfalfa silage have been made at this Station. The green fodder has been in such continual demand for feeding that not enough has been available at any time to fill a silo. Alfalfa, like clover, would require more careful packing and a greater depth of silo for best results than is necessary for corn.

HAY.

Alfalfa hay is an excellent fodder. It is palatable and very nutritious. Experience and good judgment are required, and much time and care are necessary, to make good hay. If handled too much when dry all the leaves and small stems are liable to fall off, and if not thoroughly cured it is liable to mold and mildew. The hay will not shed water well, and stacks, when left long, should be well covered. Hay caps are often of great service. The hay suffers much deterioration in feeding value by exposure to rain.

The leaves constitute in weight about half the plant—from forty to sixty per cent. Sometimes the loss of leaves and small stems amounts, with careless handling, to much more than half the weight of the crop. The ordinary loss with careful handling in about one-fifth or one-sixth. The leaves contain from three to four times as much protein and fat as the stems, and more starchy substance, while the stems contain three or four times as much woody substance as the leaves. It can be understood from this that the best part of the crop may be lost unless great care is taken. As the ash content of the leaves is also very high, the surface soil is enriched by their decay, but their great feeding value is lost.

Plate XXX.—Capons Dressed for Market.

Fig. 21.—The First Day Outdoors.

II. FEEDING EXPERIMENTS WITH CHICKS AND CAPONS.*

THE RELATIVE EFFICIENCY OF WHOLE AND GROUND GRAINS AS COMMONLY FED.

W. P. WHEELER.

SUMMARY.

A ration consisting mostly of the ordinary ground grain foods and containing no whole grain was more profitably fed to chicks than another ration consisting mostly of whole grain and containing no ground grain.

Capons from the one lot afterward made a somewhat cheaper gain in weight on the whole grain ration, but the grain was too slow to compensate for the more rapid growth which had been made, as chicks, by the lot having the ground grain ration.

Of two other lots of capons, those having the ground grain ration made the more profitable gain during several months.

In every trial more food was eaten when the ground grain was fed than when the whole grain was fed.

Neither the chicks and capons having only the whole grain nor those having only the ground grain showed any lack of health and vigor.

INTRODUCTION.

A number of experiments have been made at this Station to obtain information concerning the economy of feeding ground grain to poultry. The results from several of these tests with laying hens were published in Bulletin No. 106. The results of some other feeding experiments made at that time with young chicks and with capons seem of interest enough to warrant separate publication in this bulletin, for many inquiries are made concerning the relative advantage of feeding ground and whole grain to young stock.

*Reprint of Bulletin No. 126.

GENERAL CONSIDERATIONS.

While opinions have differed somewhat among poultrymen in regard to the manner of feeding and form of grain to be used, the different grain foods have almost necessarily, as a rule, constituted much the greater portion of all rations. In common practice there is a considerable saving of time and labor by feeding whole grain; and when it is necessary to insure exercise, as with laying hens and breeding stock, whole grain can be fed to good advantage. But by-products, much cheaper than whole grain, and, if desired, much more nitrogenous, are usually available for part of the ground grain rations. If the food consists largely of the whole grains which can ordinarily be obtained, it is not possible to secure a ration as nitrogenous as is by many considered essential.

As generally found, then, rations in which whole grains largely predominate will, unless special effort is made to prevent, have wider nutritive ratios than rations containing much ground grain. The difference is more pronounced whenever certain by-products are used and animal meal mixed with the ground grain.

So in general practice a change from "whole grain" to "ground grain" or vice versa, involves also considerable change in chemical composition of the food.

RATIONS FED.

In the feeding experiments here recorded only ordinary foods were used and such foods omitted as would make a pronounced difference in the chemical composition of the rations. There were, however, some of the usual differences in composition, although in much less degree than ordinarily occurs. An attempt to avoid any difference would have prevented the use of many common foods and this was not desired.

STOCK USED.

Two lots of chicks were fed for three months during the summer and four lots of capons for about seven months during the fall and winter. The two lots of chicks were hatched in incubators

and reared in out-door lamp-brooders. They were taken from two hatches, from which many of the chicks were used for other purposes, and, although the two lots were entirely comparable, the chicks in each lot varied a week or more in age. They were of several breeds, the Light Brahma, Dark Brahma, Buff Cochin, Partridge Cochin and some of Cochin-Game cross. The records of feeding and of growth were kept from the time the chicks were hatched until they were three months of age. The cockerels were then caponized and were fed during the winter. The pullets were also fed the contrasted rations for a while, but were too few in number to make the results satisfactory, and were not carried through.

FOODS.

The grain food for one lot of chicks, No. I, consisted from the start entirely of ground grain, and that for lot No. II, entirely of whole or cracked grain. Both lots were fed skim milk freely. Lot No. I had dried blood. Lot No. II had cut, fresh bone, all the chicks would eat, twice a week, and what dried blood they could be induced to eat with the whole grain. Of these animal foods not enough was eaten, however, to bring the amount of nitrogen in the whole grain ration entirely up to that in the other. Each lot was kept on a small enclosed grass run, surrounding the brooder, from which their green food was obtained. In some preceding experiments it had been found that the dry matter of the green food eaten by the chicks was so small that its consideration would not affect the averages for short periods. The cost also of the green food was so small as not to appear in the average estimates, but only in the aggregates for long periods. For this reason, although green food is of great importance in feeding, account of it does not appear in the data which follow.

The grain mixture, No. I, fed to the chicks, consisted of two parts by weight of corn meal, two parts of wheat bran and one part each of wheat middlings, old process linseed meal and ground oats. The mixture, No. II, fed to the capons, consisted of ten parts by weight of corn meal, two parts wheat bran, and one part each of wheat middlings, ground oats and ground barley.

CHEMICAL COMPOSITION.

The grain mixtures and other foods averaged in composition as follows:

COMPOSITION OF FOODS.

FOOD.	Water.	Ash.	Crude protein.	Crude fibre.	Nitrogen-free extract.	Crude fats.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Grain mixture No. 1	12	3.2	14.7	4.7	61.6	3.8
Grain mixture No. 2	15.8	1.8	9.8	2.9	66.2	3.5
Oat meal (granulated)	10.1	3.5	13	2	66.7	4.7
Ground oats	12.1	3.1	12	8.1	60.5	4.2
Corn meal	12.7	2.1	10.4	2.2	68.5	4.1
Wheat	12.1	1.7	12.2	2.4	69.8	1.8
Corn	12.8	1.1	8.8	1.3	72.3	3.7
Barley	13.7	2.9	12.6	4	64.6	2.2
Oats	12.8	3.4	11.7	.4	57.8	3.9
Dried blood	9.7	1.9	82.4	1.05	5 3	.2
Skim milk	90.5	.7	3.2	......	5.1	.5
Fresh bone	34.2	22.8	20.6	......	1.9	20.5

VALUATION.

In estimating the cost of food, corn meal was rated at $16 per ton, wheat bran and wheat middlings at $14, ground oats at $18 and linseed meal at $20. Wheat was rated at 69 cents per bushel, corn at 40 cents, oats at 24 cents and barley at 41 cents, granulated oat meal at 3 cents per pound and dried blood at 2 cents, skim milk at 24 cents per 100 pounds and fresh bone at 80 cents.

NUTRITIVE RATIO.

During the first few weeks the food taken by the lot having the whole grain ration had somewhat the wider nutritive ratio. During the last few weeks there was little or no difference in this respect. All the food eaten during the three months by Lot No. I showed the average nutritive ratio of 1:3.3. That eaten by Lot No. II showed a ratio approximately 1:4.6.

EXPERIMENT WITH CHICKS.

The records of feeding and the average results from the feeding trial with the growing chicks arranged in periods of one week, are given in the following tables:

FOOD EATEN BY CHICKS (LOT NO. I) FED GROUND GRAIN.

Number of days in period.	Average age of chicks at beginning of period.	Number of chicks.	Average per Chick During Period. Mixed grain.	Ground oats.	Corn meal.	Dried blood.	Skim milk.	Total food.	Approximate water-free food per day.	Total cost of food per day.	Approximate nutritive ratio.	Average gain in weight per chick during period.	Water-free food consumed for one pound gain in weight	Water-free food per day for each 100 pounds live weight fed.	Cost of food for each pound gain in weight.
	Weeks.		Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Ozs	Cts.		Ozs.	Lbs.	Lbs.	Cts.
7.....	0.1	12	0.8	0.3	1.1	0.4	....	2.6	0.3	0.02	1:2.7	0.7	3.5	17.4	4
8.....	.7	20	1.8	.3	.5	1	5.2	8.8	.4	.04	1:1.6	1.6	2.2	15.7	3.2
7.....	1.7	20	1.6	.6	1.4	.8	7.4	11.8	.6	.05	1:2.3	2	2.2	13.7	3.1
7.....	2.2	25	2.9	.3	1.1	.6	7.1	12	.7	.06	1:2.8	2.8	1.8	11.6	2.3
7.....	3.3	23	3.4	.8	1	1.1	8.4	14.7	1	.08	1:2.6	2.4	3	11.3	3.9
7.....	4.3	23	4.3	.7	2.4	1.1	10.5	19	1.2	.12	1:2.3	3.3	2.5	10.2	3.2
7.....	5.4	22	5.3	1.5	3.8	1.4	10.7	22.7	1.6	.12	1:3	3.4	3.3	10.4	4
7.....	6.4	22	6.2	1.6	3.7	2.1	10.6	24.2	1.9	.14	1:2.6	4.7	2.8	9.5	3.4
7.....	7.4	22	6.4	1.7	5.6	2	9.8	25.5	2.1	.15	1:2.9	4.1	3.6	8.7	4.3
7.....	8.4	22	6.3	2.3	5.4	1.8	8.2	24	2.1	.15	1:5.1	3.1	4.8	7.6	5.6
7.....	9.4	22	8.1	2.8	5.1	1.7	13.4	31.1	2.4	.17	1:3.2	5.5	3.1	7.5	3.6
7.....	10.4	22	8.8	2	6.7	...	10.1	27.6	2.3	.15	1:5.3	6.6	2.5	6.1	2.5
7.....	11.4	22	10	2.7	7.8	...	12	32.5	2.7	.17	1:5.3	7.9	2.4	6	2.5

FOOD EATEN BY CHICKS (LOT NO. II) FED WHOLE GRAIN.

Number of days in period.	Average age of chicks at beginning of period.	Number of chicks.	Average per Chick During Period.										Approximate nutritive ratio.	Average gain in weight per chick during period.	Water-free food consumed for one pound gain in weight	Water-free food per day for each 100 lbs. live weight fed.	Cost of food for each pound gain in weight.
			Granulated oat meal.	Cracked wheat and wheat.	Cracked corn.	Barley.	Dried blood.	Fresh bone.	Skim milk.	Total food.	Approximate water-free food per day.	Total cost of food per day.					
	Weeks		Ozs.	Ozs	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Cts.		Ozs.	Lbs.	Lbs.	Cts.
7	0.1	12	0.8	0.9	0.4	......	......	0.4	....	2.5	0.3	0.03	1:6.2	0.1	2.4	15	4.9
8	.7	19	1	1	.7	......	......	.1	2.2	5.0	.3	.04	1:5.6	.6	3.6	13.6	6.3
7	1.7	19	1.6	1.6	.7	......	......	.1	3.9	7.9	.6	.07	1:5.3	1.4	2.7	15.5	5.6
7	2.2	24	.9	2	.8	......	......	.1	4.8	8.6	.5	.06	1:5.3	1.5	4.8	12.1	7.9
7	3.3	23	1.2	2.4	1.5	......	0.4	.2	4.4	10.1	.8	.08	1:3.8	2.3	2.7	12	4.6
7	4.3	23	.7	1	1.9	......	.4	.4	8.7	13.1	.7	.07	1:3.4	3	1.6	7.6	2.7
7	5.4	22	1.1	2.1	2.3	......	.4	.2	7.1	13.2	.8	.09	1:4.1	3.9	2.3	7.1	3.7
7	6.4	22	......	9	3.3	......	......	.3	8.7	21.3	1.7	.13	1:5.8	4.7	2.7	10.9	3.4
7	7.4	22	......	5.9	4.6	......	.6	.7	9.1	20.9	1.6	.13	1:4.3	5.4	2.9	8.1	3.7
7	8.4	22	Oats.	8.6	4.7	......	.3	.7	7.2	21.5	1.9	.14	1:5.3	6.1	4.7	8.2	5.5
7	9.4	22	0.4	6.5	5.2	2	.6	2.2	14.7	31.6	2.2	.18	1:4.2	6.8	2.2	8.1	2.8
7	10.4	22	1.2	6.6	5.9	1.2	1.2	2.6	12.4	31.1	1.8	.19	1:3.8	7.6	2.5	7	3.2
7	11.4	22	.4	7.5	7.4	3	.2	1.1	14.6	34.2	2.6	.19	1:5.3	8.3	3.1	6.4	3.7

Cost of Food to Given Age and Weight of Chicks Fed Ground Grain and Whole Grain.

Lot No. I.—Ground Grain.						Lot No. II.—Whole Grain.					
Average age chicks.	Average weight per chick.	Average cost per chick to age given for food, etc.	Average weight per chick.	Cost of food per chick to weight given.	Average total cost per chick for food, etc.	Average age chicks.	Average weight per chick.	Average cost per chick to age given for food, etc.	Average weight per chick.	Cost of food per chick to weight given.	Average total cost per chick for food, etc.
Weeks.	Lbs.	Cts.	Lbs.	Cts.	Cts.	Weeks.	Lbs.	Cts.	Lbs.	Cts.	Cts.
0.1	0.1	4	0.10	....	4	0.1	0.1	4	0.10	0.1	4.2
1	.2	4.5	.25	0.7	5.1	1	.1	4.6	.25	1.1	5.8
2	.3	5.3	.50	1.3	6.2	2	.2	5.4	.50	2.1	7.2
3	.4	5.9	.75	2.2	7.3	3	.3	6.1	.75	2.8	8.1
4	.6	6.6	1	3	8.3	4	.4	6.8	1	3.7	9.2
5	.8	7.4	1.25	3.9	9.3	5	.6	7.5	1.25	4.6	10.2
6	1	8.3	1.50	4.9	10.5	6	.8	8.2	1.50	5.8	11.5
7	1.3	9.4	1.75	6.1	11.8	7	1	9.2	1.75	6.6	12.3
8	1.5	10.5	2	0.2	13	8	1.2	10.1	2	7.3	13
9	1.8	11.8	2.25	7	13.7	9	1.5	11.3	2.25	8.2	13.9
10	2	13	2.50	8.6	14.3	10	1.8	12.4	2.50	9	14.8
11	2.4	14.1	2.75	9.2	14.9	11	2.2	13.7	2.75	9.9	15.8
12	2.9	15.3	3	9.9	15.6	12	2.6	15	....	....	....
13	3.3	....	....	....	....	13	3	....	....	....	....

COST OF OIL AND FOOD.

The oil required by each brooder during the ten weeks that they were heated amounted to 4½ gallons. Considering only the cost of oil and food, the cost of the gain in weight made by Lot No. I during the three months would be 3.98 cents per pound. The cost of the gain made by Lot No. II would be 4.5 cents per pound.

RELATION OF FOOD TO GROWTH.

The food eaten during the three months by Lot No. I, having the ground grain ration, contained 31.2 pounds more dry matter than that eaten by Lot No. II and the gain in weight was 8.9 pounds greater. For every pound gain in weight made by Lot No. I there were 4.56 pounds of dry matter in the food consumed. For every pound gain in weight made by Lot No. II there were 4.4 pounds of dry matter in the food.

COST OF FOOD FOR GROWTH.

By Lot No. I one pound gain in weight was made for every 3.33 cents worth of food consumed. By Lot No. II one pound gain was made for every 3.76 cents worth of food.

At the average weight of one pound the food had cost per chick for Lot No. I, 3 cents and for Lot No. II, 3.7 cents. At the average weight of 1.5 pounds the food had cost per chick 4.9 cents for Lot No. I and 5.8 cents for Lot No. II. At the average weight of 2 pounds the cost per chick for Lot No. I was 7.2 cents and for Lot No. II 7. 3 cents. At the average weight of 2.5 pounds the cost per chick for Lot No. I was 8.6 cents and for Lot No. II, 9 cents.

RAPIDITY OF GROWTH.

The chicks in Lot No. I averaged one pound in weight at six weeks of age and in Lot No. II at seven weeks of age. In Lot No. I at ten weeks of age the average weight was 2 pounds and in Lot No. II, 1.8 pounds.

COST OF PRODUCTION.

Rating the cost of hatching (including the cost of eggs, etc.) at the average cost found in former experiments, and considering the cost of food and of oil for brooders, gives as the total cost per

Fig. 22.—Capons from Experiment Pens, 1896.

chick at twelve weeks of age 15.3 cents for Lot No. I and 15 cents for Lot No. II. The average weight per chick at this age for Lot No. I was 2.9 pounds and for Lot No. II, 2.6 pounds. In the accompanying tables will be found stated the "total cost" at different ages and weights. This total cost represents only the cost of eggs, of hatching, of heating brooders and of food. It does not account for labor or the rent of buildings or losses. There was however in no lot during this experiment any loss from disease. The chicks, and later the capons, remained in good health throughout under either ration.

FIRST EXPERIMENT WITH CAPONS.

The cockerels from these two lots of chicks were caponized and fed these same contrasted rations during the winter. The records of feeding are given in the following tables calculated to the average per fowl for periods of two weeks.

LOSS DUE TO THE OPERATION.

During the first period recorded all the birds in each lot were caponized; but notwithstanding this temporary disadvantage the average gain made for the period was a good one and at little cost for food. The average loss in weight per fowl caused by the necessary fasting and the operation was a little less than 11 per cent, not quite one-half pound each. The twelve capons in each lot were kept in one pen until January 1, and eight were fed in each lot for the rest of the winter.

RELATIVE FOOD CONSUMPTION.

During the first few weeks the ground grain ration had somewhat the narrower nutritive ratio and for the remainder of the feeding trial somewhat the wider ratio. The food eaten during the six months by Lot No. I having the ground grain ration contained 52 pounds more dry matter than that eaten by Lot No. II, but almost exactly the same total gain in weight was made; the gains being 81 pounds and 80.6 pounds respectively. After January 1 the gain in weight was slow and there was very little difference in the amount of food consumed. For the first 16 weeks

from September 10 to December 31 most of the difference in food consumption for the trial occurred. For this time the dry matter in the food was about 50.5 pounds more for Lot No. I and the gain made by this lot exceeded that made by the other by about 2.5 pounds.

GAIN IN WEIGHT AND FOOD REQUIRED.

From September 10 to December 31 Lot No. I having the ground grain ration gained one pound in weight for every 6.5 pounds of water-free food consumed, and Lot No. II having the whole grain ration, gained one pound for every 6.0 pounds of water-free food. During the six months Lot No. I made a pound gain for every 8.06 pounds of water-free food consumed and Lot No. II one pound gain for every 7.45 pounds of water-free food.

COST OF FOOD FOR GAINS MADE.

For the first four months the cost of food for each pound gain in weight made by Lot No. I was about 7.2 cents and for each pound gain made by Lot No. II 6.9 cents. For the six months the food cost per pound gain made by Lot No. I was 8.6 cents and for that made by Lot No. II was 8.3 cents.

FOOD EATEN BY CAPONS (LOT NO. I) FED GROUND GRAIN.

PERIOD.	Average per Day per Fowl.									Approximate nutritive ratio.	Average gain in weight per fowl during period.	Water-free food consumed for one pound gain in weight.	Water-free food per day for each 100 pounds live weight fed.	Cost of food for each pound gain in weight.
	Mixed grain.*	Ground oats.	Corn meal.	Skim milk.	Fresh bone.	Dried blood.	Total food.	Water-free food.	Total cost of food per day					
	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Cts.		Ozs.	Lbs.	Lbs.	Cts.
Sept. 10 to Sept. 24....	1.8	0.3	1	4.1	0.4	0.3	7.9	3.7	0.28	1:3.1	13.3	3.9	5.3	4.8
Sept. 24 to Oct. 8....	2.2	.8	1.8	3.5	.4	.2	8.9	5	.34	1:4.1	18.8	3.7	5.8	4.1
Oct. 8 to Oct. 22....	2.7	.8	1.7	4.4	.4	.5	10.5	5.8	.42	1:3.3	17.6	4.6	5.5	5.3
Oct. 22 to Nov. 5....	2.8	1.3	3	3.8	.5	.3	11.7	7	.41	1:4.5	16.4	6	5.9	6.5
Nov. 5 to Nov. 19....	2.6	.5	2.2	5.1	.6	.2	11.2	5.6	.40	1:4.3	13.5	5.9	4.2	6.6
Nov. 19 to Dec. 3....	4.9	.7	1	3.6	.2	.1	10.5	6.2	.41	1:6	5.7	15.4	4.3	21.1
Dec. 3 to Dec. 17....	3.2	.7	2.3	4	.2	.2	10.6	6	.40	1:5.3	8.8	9.5	4	10.4
Dec. 17 to Dec. 31....	3.4	.8	2.9	2.9	.4	.....	10.2	6.4	.41	1:6.9	5.4	16.6	4.1	16.9
Dec. 31 to Jan. 14....	4.9	.6	1.1	2.2	.1	.....	8.9	6.6	.37	1:6.9	6	13.8	4	13.8
Jan. 14 to Jan. 28....	3.2	.6	2.2	1.6	.4	.....	8	5.6	.35	1:6.7	6	13	3.2	12.7
Jan. 28 to Feb. 11....	1.9	.5	3	1.7	.1	.....	7.2	4.9	.30	1:7.4	2.3	......	2.7	......
Feb. 11 to Feb. 25....	2.7	.7	2.6	.9	.3	.....	7.2	5.4	.34	1:7	2.3	......	2.9	......
Feb. 25 to Mar. 10....	2.6	.7	2.4	1	.3	.....	7	5.3	.32	1:7	3.6	......	2.9	......

* Mixture No. 1 fed until November 10, No. 2 for remaining time.

FOOD EATEN BY CAPONS (LOT NO. II) FED WHOLE GRAIN.

PERIOD.	AVERAGE PER DAY PER FOWL.										Approximate nutritive ratio.	Average gain in weight per fowl during period.	Water-free food consumed for one pound gain in weight.	Water-free food per day for each 100 pounds live weight fed.	Cost of food for each pound gain in weight.
	Wheat.	Cracked corn.	Oats.	Barley.	Skim milk.	Fresh bone.	Dried blood.	Total food.	Water-free food.	Total cost of food per day.					
	Ozs.	Ozs.	Ozs.	Ozs.	Ozs	Ozs.	Ozs.	Ozs.	Ozs.	Cts.		Ozs	Lbs	Lbs.	Cts.
Sept. 10 to Sept. 24	1.2	0.9	0.5	0.3	3.4	0.4	0.1	6.8	3.2	0.25	1:5.6	9.6	4.7	4.9	5.9
Sept. 24 to Oct. 8	1.9	1.6	.8	.2	2.5	.4	.1	7.5	4.4	.32	1:5.4	18.5	3.4	5.7	3.9
Oct. 8 to Oct. 22	1.7	1.8	1	.6	3.7	.4	.3	9.5	5.3	.40	1:4.2	19.1	3.9	5.5	4.7
Oct. 22 to Nov. 5	1.7	2.6	.8	.9	3.4	.5	.1	10	6	.42	1:5.3	13.9	6.1	5.3	6.8
Nov. 5 to Nov. 19	1.7	1.9	.4	.3	5	.9	.1	10.3	4.9	.38	1:5.1	9.3	7.4	4	9.2
Nov. 19 to Dec. 3	1.3	3.4	.1	.2	3.5	.5	.1	9.1	5.1	.35	1:5.6	7.5	9.5	3.9	10.5
Dec. 3 to Dec. 17	1.7	3.3	.5	.2	3.5	.6	.1	9.9	5.8	.40	1:5.7	9.3	8.8	4.1	9.7
Dec. 17 to Dec. 31	1.4	3.6	.4	.6	2.8	.9	......	9.7	5.9	.39	1:5.9	8.8	9.3	4	9.9
Dec. 31 to Jan. 14	1.4	3.8	.3	.3	3.6	.4	......	9.8	5.6	.37	1:6.3	5.8	13.6	3.5	14.6
Jan. 14 to Jan. 28	1.3	3.5	.4	.4	3.8	1.2	......	10.6	5.5	.38	1:5.5	5.4	14.3	3.3	15.9
Jan. 28 to Feb. 11	.8	5.6	.5	.4	3.9	.1	......	11.3	6.8	.43	1:6.9	.9	....	4	......
Feb. 11 to Feb. 25	.8	2.1	.3	.4	2.2	.6	......	6.4	3.7	.25	1:5.6	10.3	5.1	2.1	5.5
Feb. 25 to Mch. 10	.4	4	.3	.6	1.9	.6	......	7.8	5.2	.31	1:6.5	3.6	....	2.9	......

Age and Size Related to Gains.

Although the birds in one lot were of the same age as those in the other, the average size at the start was greater with Lot No. I, for the chicks in Lot No. I had grown the faster. The average weight of the cockerels at the start was about 3.9 pounds in Lot No. I and 3.7 pounds in Lot No. II. A difference in weight was generally maintained until the capons were fully grown, the average weight of 10 pounds being attained much sooner by Lot No. I, and also the average weight of 11 pounds several weeks sooner than by Lot No. II.

While the gain was made much of this time at less cost by the capons having the whole grain ration it was made by birds of smaller size; and although by capons of the same age a gain was made at less cost per pound under the whole grain ration it was not the case with birds of equal size.

In this feeding experiment, as in others, the cost of any increase in weight was greater as the birds approached maturity, the most profitable gains being made by the young birds under four pounds in weight.

Cost at Different Ages.

At five months of age the food from hatching for each bird in Lot No. I having the ground grain had cost 35.5 cents and for each bird in Lot No. II 34 cents; but the average weight was 8.1 pounds in Lot No. I and 7.5 pounds in Lot No. II. Up to 6½ months of age the average cost for food was, for Lot No. I, 54 cents and for Lot No. II 52.2 cents; but the average weight at this age was 10 pounds in Lot No. I and 9.5 pounds in Lot No. II.

In the accompanying tables will be found stated the cost of food up to different ages and weights.

COST OF FOOD TO GIVEN AGE AND WEIGHT OF CAPONS FED GROUND GRAIN AND WHOLE GRAIN.

LOT NO. I.—GROUND GRAIN.						LOT. NO. II.—WHOLE GRAIN.					
Age.	Average weight per fowl.	Average total cost of food per fowl up to weight given.	Average weight per fowl.	Average age.	Average total cost of food per fowl at weight given.	Age.	Average weight per fowl.	Average total cost of food per fowl up to weight given.	Average weight per fowl.	Average age.	Average total cost of food per fowl at weight given.
Mos.	Lbs.	Cts.	Lbs.	Mos.	Cts	Mos.	Lbs.	Cts.	Lbs	Mos.	Cts.
3	3.6	12	5	3.7	17.7	3	....	13.3	5	....	19
3.5	4.6	16.3	5.5	3.8	19.9	3.5	5.2	19.5	5.5	4	22
4	6	21.9	6	4	21.9	4	5.5	22	6	4.2	24.3
4.5	7	27.5	6.5	4.3	24.7	4.5	6.7	27.5	6.5	4.4	26.6
5	8.1	35.5	7	4.5	27.5	5	7.5	34	7	4.7	30
5.5	8.9	41.4	7.5	4.7	30.9	5.5	8.1	40	7.5	5	34
6	9.4	47.8	8	4.9	34.7	6	8.7	46	8	5.4	38.7
6.5	10	54	8.5	5.2	37.8	6.5	9.5	52.2	8.5	5.8	43.7
7	10.5	60	9	5.6	42.8	7	10.1	58	9	6.3	48.5
7.5	10.9	65	9.5	6.1	49	7.5	10.4	63.5	9.5	6.5	52.2
8	11.1	70.2	10	6.5	54	8	10.7	69.8	10	6.9	57.2
8.5	11.3	75	10.5	7	60.1	8.5	11	73.5	10.5	7.7	65
9	11.5	79.5	11	7.7	66.8	9	11.3	79.2	11	8.5	73.5
9.5	....	84.4	11.5	9	79.5	9.5	11.4	83.2	11.5	10	87.2
....	....	....	....	....	....	10	11.5	87.2	....	....	....

SECOND EXPERIMENT WITH CAPONS.

Two other similar lots of capons were also fed these contrasted rations for about five months. These were from a lot of young birds that had been hatched under hens and grown by the ordinary methods. The food and care had been alike for all until after the cockerels were caponized and separated for this feeding trial. The capons were of the same breeds used in the trials just reported. Record of feeding was not begun until some days after the cockerels were caponized. There were 12 capons in each lot until January 30, and then 8 for the rest of the trial. At the beginning of this trial the capons in the two lots averaged exactly alike in weight, a trifle less than 5½ pounds each.

Rations.

Lot No. III was fed the ground grain ration like that fed to Lot No. I, and Lot No. IV was fed the whole grain ration like that fed to Lot No. II. With both rations the nutritive ratio was narrower at the commencement of the feeding trial and wider toward its close. The average nutritive ratio was the same for each lot.

Relative Food Consumption and Gain.

During the whole time of feeding, Lot No. III having the ground grain ration consumed 13.4 pounds more water-free food than Lot No. IV having the whole grain ration and gained 12 pounds more in weight. Lot No. III made one pound gain for every 8.3 pounds of water-free food consumed and Lot No. IV made one pound gain for every 10.1 pounds of water-free food.

During the last 8 weeks there was very slow increase in weight with both lots. During the first eleven weeks Lot No. III consumed 15 pounds more water-free food and made 3 pounds more gain in weight than Lot No. IV. One pound gain was made for every 6.8 pounds of water-free food by Lot No. III and one pound gain for every 6.9 pounds by Lot No. IV. The cost of food for each pound gain made by Lot No. III was 7.2 cents and for Lot No. IV, 7.8 cents.

FOOD EATEN BY CAPONS (LOT NO. III) FED GROUND GRAIN.

PERIOD.	Average Per Day Per Fowl.									Approximate nutritive ratio.	Average gain in weight per fowl during period.	Water-free food consumed for one pound gain in weight.	Water-free food per day for each 100 pounds live weight fed.	Cost of food for each pound gain in weight.
	Mixed grain*	Ground oats.	Corn meal.	Skim milk.	Fresh bone.	Dried blood.	Total food.	Water-free food.	Total cost of food per day.					
	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Cts.		Ozs.	Lbs.	Lbs.	Cts.
Oct. 31 to Nov. 7	2.5	1.1	1.9	2.4	0.4	0.3	8.6	5.6	0.37	1:4	15.8	2.5	5.8	2.7
Nov. 7 to Nov. 21	2.7	.6	2.2	6	.5	.2	12.2	5.9	.49	1:4.1	13	6.4	5.4	7.3
Nov. 21 to Dec. 5	3	.6	1.9	4.4	.3	.2	10.4	5.7	.38	1:4.4	14.3	5.5	4.6	6
Dec. 5 to Dec. 19	3.3	.7	2.7	2.5	.2	.2	9.6	6.2	.40	1:5.7	9	9.7	4.6	10.1
Dec. 19 to Jan. 2	4.7	.6	1.9	2.1	.2	......	9.5	6.1	.38	1:6.8	7.2	12	4.3	12
Jan. 2 to Jan. 16	4.2	.7	1.1	2.1	.1	......	8.2	5.4	.34	1:6.8	6.7	11.3	3.6	11.3
Jan. 16 to Jan. 30	2.5	.7	2.4	1.8	.2	......	7.6	5.1	.32	1:6.7	5.5	13	3.3	13
an. 30 to Feb. 13	2.4	.8	3	1.5	.1	......	7.8	6.4	.34	1:7.1	4.8	16.3	4	16.1
Feb. 13 to Feb. 27	4.5	.4	1	1	.2	......	7.1	5.2	.32	1:7.1	2.3	......	3.2	......
Feb. 27 to Mar. 12	2.8	.4	2.5	.9	.2	......	6.8	5.2	.30	1:7.6	6.1	11.8	3	10.9

* Mixture No. 1 fed until December No. 2 for remaining time.

FOOD EATEN BY CAPONS (LOT NO. IV) FED WHOLE GRAIN.

PERIOD.	Average per Day per Fowl.										Approximate nutritive ratio.	Average gain in weight per fowl during period.	Water-free food consumed for one pound grain in weight.	Water-free food per day for each 100 lbs. live wt. fed.	Cost of food for each pound gain in weight.
	Wheat.	Cracked corn.	Oats.	Barley.	Skim milk.	Fresh bone.	Dried blood.	Total food.	Water-free food.	Total cost of food per day.					
	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Cts.		Ozs.	Lbs.	Lbs.	Cts.
Oct. 31 to Nov. 7......	2.3	2.2	0.4	0.8	2	0.5	0.3	8.5	5.8	0.42	1:4.5	9.8	4.1	6.3	4.8
Nov. 7 to Nov. 21......	1.9	2.2	.4	.5	5.8	.7	.4	11.9	5.7	.45	1:3.8	14.1	5.6	5.4	7.1
Nov. 21 to Dec. 5......	1.9	3	.3	.3	3.9	.7	.1	10.2	5.7	.41	1:5.1	12.7	6.3	4.9	7.3
Dec. 5 to Dec. 19......	1.2	3.3	.4	.9	3.1	.6	......	9.5	5.6	.37	1:6.7	10.8	7.3	4.3	7.8
Dec. 19 to Jan. 2......	1.5	3.2	.4	.1	2.7	.7	......	8.6	5.2	.35	1:6.1	5.7	12.8	3.8	13.8
Jan. 2 to Jan. 16......	1.3	3.5	.4	.6	2.6	.4	......	8.8	5.5	.36	1:6.4	8.9	8.7	3.8	9.1
Jan. 16 to Jan. 30......	1	2.4	.4	.6	3	.7	......	8.1	4.5	.31	1:5.5	.8	......	3.8	......
Jan. 30 to Feb. 13......	1.6	3.4	.6	.6	4.1	.3	......	10.6	5.9	.40	1:6.2	11.9	......	3	......
Feb. 13 to Feb. 27......	.6	3.9	.7	.7	2.6	.6	......	9.1	5.7	.36	1:6.2	4.6	......	3.5	......
Feb. 27 to March 12......	.9	4	.3	.4	2.3	.6	......	8.5	5.4	.34	1:6.4	5.4	......	3.3	......

GENERAL REMARKS.

In these feeding trials all the fowls remained in good condition throughout, the capons as well as the young chicks, and no differences were noticeable in the general vigor. The birds in the two lots were fed from hatching up to weights of from 10 to 14 pounds each at ten months of age, the one lot having had no whole grain and the other lot no ground grain, without any difference being apparent except in the amount of food eaten and rapidity of growth.

At the prices of foods assumed for the season 1896 (mentioned on page 564) the ground grain ration gave the greater profit in general. There was a somewhat more profitable gain made for several months by the one lot of capons with the whole grain ration, but the birds were enough longer in reaching marketable maturity to make the profit greater with the contrasted lot.

The rations which contained only the ordinary foods, showed some of the usual differences in composition, but these differences were much less than usually exist between rations of whole and ground grain.

The capons marketed after the close of the feeding experiment sold readily at retail in the local market for 20 cents per pound. The loss of weight in dressing was small, being almost entirely due to the fasting necessary to empty the crop. At this price there was a good margin over the cost of food under either ration. The accompanying illustration is from a photograph of a number of these capons ready for market.

REPORT

OF THE

Department of Field Crops.

W. H. JORDAN, Sc. D., Director.
G. W. CHURCHILL, Agriculturist.

Table of Contents.

REPORT OF THE DEPARTMENT OF FIELD CROPS.

I. THE OUTLOOK FOR THE SUGAR BEET INDUSTRY.*†

W. H. JORDAN.

SUMMARY.

The following facts may be regarded as favorable to the successful production of beet sugar:

(1) The experience of 1897, so far as a single season can show, appears to demonstrate that our climatic and soil conditions are adapted to the growth of beets which are satisfactory in quantity and quality of yield.

(2) The cultivated lands of central and western New York may be so managed as to compete with any in the United States in those lines for which they are adapted.

(3) The ability of the American farmer to take up a new enterprise successfully is a helpful factor. American inventive genius may also be relied upon to provide implements necessary to cheap culture.

(4) At present there is an unlimited home market at good prices for all the sugar that can be produced; but it cannot be definitely known how long this condition may last.

(5) An added cash crop yielding fair returns is most desirable for our farmers.

The following facts must also be considered in connection with those preceding:

(1) To cultivate a plant so sensitive in regard to its content of sugar as the sugar beet requires such careful attention to details as is demanded by no other crop commonly grown on our farms.

*A reprint, largely, from an article in the *Country Gentleman*, Dec. 30, 1897.
†Partial reprint of Bulletin No. 135.

(2) There is danger of regarding exceptional yields as representing the average. An average of 12 tons of beets an acre for the first few years may be regarded as a fair average, if we are to judge by results secured in other places.

(3) There is danger that capital may be inefficiently directed in the erection of factories, as this is a line in which our eastern business men have had no experience. Beet-sugar manufacture should be entered upon with great caution and only after exhaustive study of the problems involved. Farmers should be cautious about taking stock in factories, unless the men who control the enterprises are personally known to and trusted by them.

(4) The question of home and foreign competition must not be ignored. Strong competition will come from the Pacific States until their soils become exhausted. We shall be brought into competition with the lower wages paid in Europe, if at any time the strong sentiment existing in favor of free sugar comes to find expression in tariff regulations.

Taking all facts into consideration, farmers may not expect to realize unusual profits for any long period of time from the growing of sugar beets. The crop promises to become one which will give satisfactory returns to those who learn to grow it successfully.

FAVORABLE CONSIDERATIONS.

The forecasting of the future of any new industrial enterprise is a difficult matter. This is so because the conditions affecting production, manufacture, competition and market prices, which are sure to prevail for any length of time, cannot be definitely known; and the discussion now going on throughout the entire State of New York relative to the establishment of beet sugar factories in our midst deals with the usual number of indefinite factors.

The situation is such, however, that all who attempt to influence the public opinion should take a conservative position in this matter, one that will be justified by future events.

There are some facts which are regarded as favorable to a successful production of beet sugar. The experience which has been

gained in the season of 1897 certainly indicates that our soils and climate are favorable to the growth of beets which are satisfactory in quantity and quality. Of course figures in great variety have been reported from a large number of experimental plats, varying from very low yields to those which are suspiciously high. The experience on the Station farm this year in the culture of two acres of beets indicates that by proper methods the best farmers may possibly produce in favorable seasons from 15 to 18 tons of high grade beets. The average crop will doubtless be considerably below this. It must be confessed, however, that one season's experience is not enough upon which to base final conclusions.

It is unquestionably true that the cultivated lands of central and western New York are capable of a high rate of production of almost anything which is adapted to the conditions there prevailing. These lands, managed by intelligent farmers, may compete with any in the United States, and this is entirely favorable to success in growing sugar beets, after it is established that the conditions are suitable to this crop.

The capacity of the American farmer is cited as an evidence of his probable success in whatever he undertakes. This is, certainly, a strong argument. In intelligence, industry and capacity to master the details of new methods, even expert methods, he is not excelled by the farmers of any civilized country. We may expect, moreover, that the inventive genius of American manufacturers will meet the farmer half way in providing the implements necessary to cheap culture.

The enthusiastic advocate of this new enterprise claims the certainty of an unlimited market for the sugar. It is true that we now buy from eighty to a hundred million dollars' worth of beet sugar from France, Germany and other countries, and so long as a protective tariff places the foreign producer at a disadvantage, we may reasonably expect to be able to sell at fair prices all the sugar we can produce for some time to come. Regarded with reference to the immediate future, this argument appears to have weight. The doubt here lies with the continuation of existing conditions.

It will be an undoubted gain, too, if we can add another cash crop to those which we already regard as yielding fair returns for the labor expended and a moderate rental for the land. Crops which find a steady sale at living prices are needed by the American farmer. Every new, successful crop also tends to prevent overproduction along other lines.

THE OTHER SIDE.

There are many facts to be considered on the other side of this question, which, while not necessarily arguments against an attempt to produce and manufacture beet sugar in this State, nevertheless are worthy of the most careful attention.

In the first place, the sugar beet is a highly bred plant, sensitive, so far as content of sugar is concerned, to the conditions under which it is grown. The farmers who cultivate it successfully must be those who are willing to adhere faithfully to definite, careful methods. This does not mean that a minority of our farmers will not succeed, but that the average results are almost sure for a time to be disappointing, and it is average results which will determine the success of the business when broadly considered. Beet-sugar factories cannot be maintained unless the average experience of farmers in the growth of this crop is satisfactory.

We are greatly elated over the high percentages of sugar which have been found in New York beets this season, but we must bear in mind that high quality and a large production, as some regard production, are not consistent.

Some samples which have been sent to this Station for analysis have been accompanied by a statement that the crop of beets produced was at the rate of thirty tons per acre. It is probable, either that the method of estimating these crops was not a safe one, or that the beets were not properly grown. Erroneous and greatly excessive figures are very likely to result from computations based upon the theoretical possibility of growing a certain number of a certain size of beets per acre, or from the weight of a short section of a row of beets. Nothing short of the weighing

of the entire actual product from a fairly extensive area will give safe figures.

The yield this year on the Station farm from a two-acre field was at the rate of sixteen and a quarter tons per acre, which quantity, after cutting off the top of the beet in the manner required at the factory, and making due allowance for dirt, was considerably reduced. This field of beets was on some of the best land the Experiment Station farm contains, and was given thorough cultivation and the best of care. The sugar content in this crop was very satisfactory.

It is significant that during the past five years the average production in Belgium, and also in Germany, has varied from about eleven to approximately thirteen and a half tons per acre. To be sure these are averages, and while averages are not a measure of what the best farmers may do, they are the standards by which, as before stated, the success of a business must be gauged. We should not expect the American farmer to do much better than the European farmer, where this industry has for a long time existed, especially at first. New York farmers, if they enter upon the production of sugar beets, will have occasion to congratulate themselves, if, for the first two or three years they reach an average of twelve tons of high grade product per acre. This is not necessarily a condemnation of the business.

We must remember still further that it is necessary for the farmer and the manufacturer to be mutually prosperous, and there certainly are some facts which seem to warrant careful consideration, by the farmer, of the manufacturer's side of the business.

There is great danger that much of the capital which is likely to be invested in this new enterprise will be inefficiently directed. The manufacture of beet sugar is something with which eastern business men have had no experience, and no careful study of means and methods will take the place of the knowledge which comes from experience. Disasters to capital which may cause losses to farmers are to be feared. It behooves business men, therefore, to proceed with the erection of beet-sugar factories

with great caution and only after the most exhaustive study of the problems involved.

Doubtless farmers will be invited to invest in beet-sugar factory stock. They will be told not only that the stock will be profitable, but also that it is their duty to share in the risks. They should be very careful in this matter. If the professional boomer appears among them, they should give him a wide berth. He may be resourceful in plausible argument, and it may be hard to resist the fascination of his apparently sound reasoning; but unless the farmers resist his appeals, history will repeat itself, and shares of worthless stock will be very widely distributed among those who cannot afford to suffer the loss. This does not mean that under certain other conditions farmers may not wisely own a share of the factory. If local business men of unquestioned integrity and sound business judgment take the lead in the new enterprise—men who as the directors of banks and other financial organizations have won the confidence of the community by their successful and honorable methods—then perhaps the farmer may as safely entrust his money to them in this enterprise as in some others.

In discussing this matter we should ignore neither home nor foreign competition. The immense factory which Spreckels is erecting in the West to be sustained from cheap western fertility, is a significant beginning. Certainly if beet-sugar production and manufacture are at first unusually profitable we may expect to see this industry rapidly develop to a condition of the usual competition.

Prof. Brooks, of Massachusetts, has recently pointed out the fact that we can hardly compete with the lower wages paid in foreign countries, but he failed to note that the necessary fuel and limestone are much cheaper in the United States than in France and Germany. Probably European producers will have no advantage over us so long as we have a protective tariff, but we know how strong a sentiment there is in this country in favor of free sugar, and political revolutions are likely to make changes in the tariff conditions affecting this commodity. It seems prob-

able, though, that the existence of a new industry in the early stages of successful development might modify or prevent legislation that would otherwise take place.

There is, however, a law of compensation operating in the world's industries to which we must give proper weight. We cannot safely leave out of account the rest of the world in estimating what may be done through a period of years along any line of production. It is a narrow view which only discovers that we are not producing our own sugar.

CONCLUSIONS.

What conclusions, then, shall we draw from all these facts and conditions? It seems very probable that farmers will not realize unusual profits for any extended period of time from sugar-beet growing. The facts appear to justify the belief, however, that this crop may come to rank among those which for some time will be regarded as giving satisfactory returns. It will be a business of moderate profits and one that will not spring into uninterrupted success. If it is a success at all, it will become so by growth through education and experience. Above all, the manufacturer must guard the interests of the farmer, and the farmer must be able to have confidence in the manufacturer, and both must have a patient faith in the final triumph of intelligent means and reliable, conservative methods of management.

II. THE STATION EXPERIMENTS WITH SUGAR BEETS.*

G. W. CHURCHILL.

SUMMARY.

(1) Soil used. The soil was a heavy clay loam, in good condition of fertility and cultivation.

(2) Planting, cultivation and harvesting. The land was ploughed and subsoiled 14 inches deep on May 7 and 8. Commercial fertilizer was applied at the rate of 950 pounds an acre. The surface was given careful preparation and the seed sown on May 17 at the rate of 15 pounds an acre. About June 1 the rows of plants were distinguishable and a hand cultivator was run through them, which was soon followed by hoeing and partial thinning. On June 15 a horse cultivator was used and the final thinning commenced. This was followed by two more cultivations. Harvesting began September 22.

(3) Cost of crop. On a basis of wages commonly paid for labor, the cost amounted to $75.80 an acre; on a basis of cheaper labor, the cost was $54.30.

(4) Yield. The yield was 32,548 pounds an acre or about 16¼ tons. For 1,000 pounds of beets, the loss of weight caused by cutting off the crowns was 73 pounds; and the loss of weight caused by washing off the dirt was 49 pounds. This would make a yield of marketable beets equal to 15.1 tons an acre.

(5) Size and composition. The average weight was 12 ounces. The beets contained 15.2 per cent sugar, equivalent to 16 per cent sugar in juice, having a coefficient of purity equal to 81.

(6) Influence of fertilizer. The yield was increased about 6 tons an acre by the use of fertilizer.

*Partial reprint of Bulletin No. 135.

SOIL, PLANTING AND CULTIVATION.

The field selected for the experiment with sugar beets is a clay loam bordering on what is usually termed heavy, having a tendency to "puddle" when overcharged with moisture, and to cake or crust over when quickly dried by a hot sun and wind. If not disturbed in times of drought it will soon seam or crack open.

These features are characteristic of a large portion of the farm lands of this section, and render the growing of small seed crops more difficult and expensive than on sandy or porous loams.

From a farmer's point of view, this soil would be considered to be in a good state of cultivation and fertility. The crops in the rotation that have been grown on it during the past ten years have yielded fully up to, if not above, the average of the farm lands in this section of the State.

The two-acre plat which was selected had been used for fertilizer experiments with potatoes in 1896.

On May 7 and 8 the land was ploughed and subsoiled to the depth of fourteen inches, and the surface was worked down with springtooth harrow, followed by a Thomas smoothing harrow, and finished by rolling.

On May 11, after working down with the springtooth harrow, and before smoothing, 950 pounds per acre of the following mixture of commercial fertilizers was sown broadcast:

Sulphate of potash	250 pounds, 50 per cent K_2O
Acid rock	300 pounds, 14 per cent P_2O_5
Dried blood	200 pounds, 10 per cent N.
Nitrate of soda	200 pounds, 15 per cent N.
Total	950 pounds.

After the fertilizer had been sown and thoroughly worked in, the ground was smoothed and rolled. A marker to be drawn by one horse was then constructed from an old corn marker so that five rows could be lined out at one time, at a distance of twenty inches apart.

The teeth were fitted at the bottom with shoes about eighteen inches in length and three inches deep, made from one and one-half inch plank. These were fastened by cutting a notch out of the bottom of the tooth one and one-half inches wide and about three inches deep. Holes were bored through the teeth at right angles to the shoes. Bolts passing through these holes and a corresponding hole in the shoe fastened the latter and the tooth together. The first plan for having the shoes work freely on the bolts as pivots was modified by nailing beveled blocks or the back of the teeth just above the shoes, making them stationary. The difficulty encountered in the loose shoe was that when any resistance was met by the forward part, it would tip down, and in digging into the soil raise the rear end out of the ground, thus throwing the whole marker out of line. After this change the marker, though crude, worked to our entire satisfaction, making a mark about one inch deep and two inches wide, which could be followed with ease by the seeder.

After seeding six rows an unexpected and very heavy shower of rain so saturated the ground that it was impossible to continue the work until May 17.

It was a mistake to completely fit the entire plat before commencing to sow the seed, for we were obliged to again harrow and roll the ground before seeding could be resumed. The only safe way is to prepare the ground as needed, thus avoiding the extra expense of re-working after every rainfall.

Another mistake was made which was a source of annoyance throughout the season. Because of haste to complete the seeding as soon as possible, the small stones scattered over the plat were not picked. While these did not affect the growth of the beets, they were a hindrance in seeding, and, later, in the cultivation of the crop. It would have been economy in the end if they had been removed. Any obstruction in the way of the seeder will give it a jerky motion which will bunch the seed. The motion should be smooth and continuous in order to allow an even distribution of seed. Later the stones interfered with hand and horse cultivation and more or less with hoeing and thinning the beets.

The seed was sown with an "Improved Model" Mathews hand drill. It was found that by attaching the ends of a rope to the seeder, and fastening a short strap to this, making a device similar to a "breast collar" used in single harness, that two men, one to draw and the other to push and guide the seeder, could accomplish more than double the work of one man alone, and with greater ease and efficiency. Doubtless seeders will be used that will sow several rows at one time.

With the exception of six rows sown at an earlier date, two men sowed the two-acre plat in eight hours. The only fault that could be found with the seeding was the bunching of the seed in places where small stones or clods were encountered by the drill, causing it to slacken motion or to stop altogether. When this happened, several seeds were dropped within a very small compass, and before the seed commenced flowing again the machine had moved along, leaving a space without any seed.

Fifteen pounds of seed were sown to the acre. The ground was moist and in good condition for promoting quick germination, and vegetation commenced in about ten days from the time of seeding. About June 1 the plants were large enough for the rows to be easily distinguished and the hand cultivator was started, the machine used being a "Buckley," having several combinations of blades.

The arrangement that was found to work to the best advantage at this time was a broad V-shaped blade set in the center of the frame in front, and two smaller ones set on the right and left sides of the frame well to the rear of the machine. These latter are flat pieces of steel sharpened on the edges, and made to form a right-angle turned so that the points extend toward the center of the row, and as they are about eight inches in length they nearly meet in the middle, forming what is commonly termed a "a scarifier." One advantage of this form of blade is that the crust can be broken very near to the young plants without throwing the dirt over them. Soon after this cultivation, hoeing and the first or partial thinning were commenced. For the work of partial thinning the blades of ordinary hoes were cut down to four inches.

By cutting across the row with such a hoe, bunches were left which could be thinned, leaving the plants from six to nine inches apart. At the same time the soil was loosened around the plants and all of the weeds removed.

On June 15 the beets were cultivated with a one-horse Syracuse harrow-tooth cultivator, and the final thinning commenced.

It was intended to have the beets left eight inches apart in the rows. It was found necessary in some cases, however, to vary these distances on account of the spaces left by the seeder, and in order to preserve the strongest plants.

After the final thinning, the beets received another cultivation to loosen the ground, as it had become more or less compacted by rain and the passing of the men while thinning. After this but one more cultivation with the horse cultivator was given, for the beet tops covered the ground to such an extent that a horse could not pass through without doing serious damage. The subsequent hand labor was small, and would not have been considered necessary by many growers, but in order to adhere to strictly clean culture, men were sent through the field once to pull the weeds that had escaped previous cultivation. This consumed less than one day's time for two men, and at the time of harvesting the crop the field was entirely clear of weeds.

HARVESTING AND RESULTS.

The harvesting of the beets began on September 22. Two methods were tried; first, plowing three furrows for each row, the third furrow turning out the beets, and plowing two furrows for each row, after which the beets were pulled by hand. The last named method seems preferable where the beets do not have too long tap roots, because in the first method the small beets are covered by the furrow and it is more work to uncover them by hand than it is to pull them out when they are standing upright and in plain sight.

As the beets were pulled out they were thrown in heaps, and men followed aud cut off the tops. The harvesting, which includes pulling, topping and hauling, was found to be the most expensive operation connected with the growing of this crop.

It should be borne in mind that the very best of culture was given throughout the season and no expense spared in either hand or team labor, and that a liberal allowance has been made in all cases wherever estimates were necessary. Some mistakes were also made which were costly, and which can be avoided in the future. On the whole, therefore, it is probable that these figures err on the side of too great cost, and that with the experience gained in this season's work, we can cheapen the cost of growing an acre of beets quite materially.

In the table below we give the cost of growing one acre of sugar beets, based on hand labor at $1.25 per day for hoeing and thinning, and team at $3.50 per day; and on hand labor at $0.75 and team at $3.00:

COST PER ACRE OF GROWING SUGAR BEETS.

	Expensive labor.	Cheap labor.
Fitting ground	$7 00	$6 00
Sowing fertilizer	1 12	1 12
Sowing seed	1 25	1 25
Hoeing, thinning and weeding	23 43	13 88
Harvesting	24 25	14 80
Horse cultivation	2 00	2 00
Hand cultivation	3 75	2 25
Seed	3 00	3 00
Fertilizer	10 00	10 00
Total	$75 80	$54 30

Doubtless these figures will be criticised on the ground that they are too high, but it is probable that, if careful accounts were kept by one hundred farmers of the cost of everything connected with the growing and delivery to the factory of one acre of properly grown sugar beets, the average would not fall below $50.00, with the present methods and machinery at the command of the grower.

The yield per acre, as harvested, was 32,548 lbs., or approximately 16¼ tons.

In order to determine the actual yield of perfectly clean beets, topped as they would be when sent to the factory, a lot weighing

38

1,000 lbs. was thoroughly washed and dried, after which the crowns were removed.

Weight of beets taken	1000 pounds.
Loss by washing	49 pounds.
Weight of crowns	73 pounds.
Weight of washed beets without crowns	878 pounds.

At this rate the yield of topped, washed beets was 14 tons 577 lbs.; of topped, unwashed beets 15 tons 200 lbs. At $4 per ton the returns per acre would not be over $60.

The shape of these beets was very satisfactory. With but few exceptions, they were symmetrical and sent down a tap root to a good depth.

The average size was rather small, being not over three-fourths of a pound. This was the result of close planting, as the average distance between the beets was probably less than eight inches. The beets grew wholly in the ground, no special precautions being necessary to secure this result excepting the subsoiling. A careful chemical examination of these beets gave the following results:

Sugar in beets	15.2 per cent.
Sugar in juice	16 per cent.
Coefficient of purity	81

According to these figures about 12 lbs. of sugar could actually be made from 100 lbs. of washed topped beets. This shows that the yield of manufactured sugar from the Station farm would be 3,429 lbs. per acre.

An observation was made on the value of an application of commercial fertilizer in sugar beet growing. The plat from which the two acres of ground was measured for the experiment recorded contained an additional area of four-fifteenths of an acre. This ground was prepared with the two-acre plat and received the same treatment, except that it was not fertilized in any way. The seed was sown at the same time and the crop received the same treatment, only that it was the last to be reached in thinning. From the start a marked difference was noticed

in favor of the fertilized plants. The young plants did not vegetate so quickly on the unfertilized plat, and afterwards they were not so vigorous as on the fertilized area.

The yield of beets on the unfertilized portion of the field was between 7½ and 8 tons per acre, which shows that the fertilizer caused an increase of at least 6 tons of beets. At four dollars per ton this increase would pay for at least twice the amount of fertilizer used.

III. COMMERCIAL FERTILIZERS FOR POTATOES.*

W. H. JORDAN.

SUMMARY.

In experiments on four farms including eight acres of land and eighty plats, the production of potatoes from the application of 500 pounds, 1,000 pounds, 1,500 pounds, and 2,000 pounds of commercial fertilizer per acre was ascertained.

(1) The use of 1,000 pounds of fertilizer per acre gave the greatest profit. The slightly larger yield caused by increasing this application to 1,500 or 2,000 pounds, cost in fertilizer expense considerably more than the market value of the potatoes.

(2) The fertilizer cost of the increased yield of potatoes where 500 or 1,000 pounds of fertilizer was used per acre was 20 cents per bushel in those experiments that proceeded without unfortunate conditions.

(3) The yield of tubers from the L. I. formula was somewhat larger than from a formula compounded with reference to the composition of the potato plant.

(4) The evidence obtained in these experiments concerning the relative effect of the muriate and the sulphate of potash upon the composition of the potato tuber is inconclusive.

(5) The proportions of the valuable plant-food compounds found in the potato tubers were not influenced appreciably by the amount or kind of fertilizer used.

INTRODUCTION.

The economical purchase and use of commercial plant food is at present one of the very complex problems of Agriculture. This is especially the case where intensive methods of culture are followed and where the larger part of the materials needed for the production of crops must be obtained from some source outside the soil.

*Reprint of Bulletin No. 137.

There are at least three important factors which should be considered in an attempt to buy and use commercial fertilizers with profit.

(1) The quantity of fertilizer to be applied should receive careful consideration. Where a rapid rotation of crops is followed, with severe cropping, this amount should not exceed that which is necessary to secure the màximum *profitable* increase of the immediate crop. The largest possible crop is not necessarily the most profitable and a great excess of unused available plant food, especially of nitrogen, at the end of the growing season does not conduce to economy.

(2) The fertilizer should be purchased, so far as possible, with reference to both soil deficiencies and the needs of the crop. As a rule the soil is the controlling factor.

(3) The fertilizer applied should be one that will promote the highest quality in the crop to be grown.

With our present knowledge it is easier to state these principles than to point out their application to specific cases, and much of the experimental work now being conducted in the field of plant nutrition is directed towards answering the questions which relate to these fundamental considerations.

The farmers of Long Island are especially interested in all that pertains to commercial fertilizers. In no part of New York are these manures more largely purchased in proportion to the acreage of tilled land, and in but few localities do the conditions so fully justify the very large money expenditure which this involves. In the first place these farmers are in close proximity to one of the world's largest markets, requiring an enormous supply of market-garden and forcing-house products. Land so situated must be worked intensively, which requires a liberal and continuous use of manures. In the second place, much of the soil in this locality does not possess great original fertility. Its natural supply of available plant food is small, even with the best of culture. Long Island farmers are obliged, therefore, to go to the markets for a large part of the plant food which they need in such generous quantities. An outlay of $800 to $1,000

for commercial manures on a farm of forty or fifty acres is not unusual. It is probable, therefore, that in this locality there is no direction which offers so promising an opportunity for the practice of economy.

THE QUANTITY OF FERTILIZER.

It is fair to inquire, first of all, whether the quantity of fertilizers which is used on Long Island farms is not often excessive. In many instances as much as one ton of high grade superphosphate is used per acre. Potato growers often fertilize their land at this rate. Is this profitable? The results of two years' experiments reported by Dr. Van Slyke, in Bulletins Nos. 93 and 112, indicate that it is not, when only the immediate crops are considered. In these experiments three quantities of fertilizer were applied, viz., 1,000 lbs., 1,500 lbs. and 2,000 lbs. per acre and in every instance the largest profits resulted from the use of 1,000 lbs. Slightly larger crops were obtained with 2,000 lbs. than with 1,000 lbs. of fertilizer, but the greater yield from the former quantity did not equal the greater cost. Moreover, the second year's effect of the different quantities of fertilizer, although quite marked, was practically the same with 1,000 lbs. and with 2,000 lbs.

These facts are not surprising when we consider the quantities of plant food which are applied to the soil in one ton of fertilizer as compared with the amounts of nitrogen, phosphoric acid and potash actually removed by a fairly large potato crop. Assuming that the tops are returned to the soil, the average of analyses herewith reported shows that a potato crop of 200 bushels removes from the soil about 36 lbs. nitrogen, 13 lbs. phosphoric acid and 60 lbs. potash.

If the fertilizer used is made after the formula so commonly in favor on Long Island, viz., 4 per cent N, 8 per cent P_2O_5 and 10 per cent K_2O, the needs of the crop and the plant food supplied by 2,000 lbs. would compare as follows:

INGREDIENTS APPLIED IN FERTILIZER AND REMOVED BY TUBERS.

	Nitrogen.	Phosphoric acid.	Potash.
	Pounds.	Pounds.	Pounds.
Contained in fertilizer	80	160	200
Removed by tubers	36	13	60
Excess in fertilizer	44	147	140

Of course much larger crops of potatoes are sometimes raised, but it would seldom be the case that the increase of crop over what the soil would produce with no fertilizer would exceed 200 bushels. In fact that is probably more nearly an average total crop, and when we take into consideration what the soil itself will furnish of plant food, it becomes a serious question, even if considered wholly from the theoretical standpoint, without the aid of experimental evidence, whether the constant addition to the soil of such an excess of the valuable manurial ingredients is profitable. It is certainly of the highest importance that farmers shall learn the truth in regard to this matter.

EXPERIMENTS ON LONG ISLAND.

THE EXPERIMENTS NOW IN PROGRESS.

The ultimate effect of any system of fertilizing the soil cannot be ascertained without a long and continuous series of observations on the same piece of land. It is entirely possible that while the application of a ton of fertilizer per acre would not be warranted by the returns from a single crop, the larger returns throughout an entire rotation might justify it. In view of these facts, the present series of fertilizer experiments has been planned with reference to their continuance for a period of years sufficiently extended to form the basis of safe conclusions. The possible large errors in plat experimentation are clearly recognized, but it is believed that with the precautions which are taken to minimize these errors they certainly cannot obscure any important effect of a particular system of manuring the land.

THE QUESTIONS ASKED OF THE EXPERIMENT.

The main object of this experiment is to get information in regard to the profitable quantity of fertilizer to be used, but there are certain incidental problems which may be studied in connection with the main one without diverting the work from its chief purpose.

Three questions are asked, therefore:

(1) What is the profitable amount of commercial fertilizer to apply in potato growing?

(2) Shall we apply plant food in the proportions used by the potato plant or in some other?

(3) Is the sulphate of potash preferable to the muriate for use in growing potatoes?

THE FERTILIZERS USED.

The purposes of this experiment require the use of four different mixtures of fertilizing materials, the ingredients and actual composition of which are given below.

Formula No. 1.—This formula is supposed to contain plant food in nearly the proportions used by the entire potato plant excepting that the phosphoric acid is in considerable excess; and was mixed as follows:

POTATO FORMULA A.

Ingredients.		*Composition.*	
Nitrate of soda.......	192 pounds.	Nitrogen	6.6 per cent.
High grade dried blood	800 pounds.	Available phos. acid	4.75 per cent.
Acid phosphate.......	570 pounds.	Potash	10.31 per cent.
Muriate of potash.....	400 pounds.		
Land plaster..........	38 pounds.		
	2000 pounds.		

Formula No. 2.—This formula was intended to contain the same percentages of the three ingredients as Formula No. 1, the only difference being that the potash is supplied as the sulphate instead of the mutriate.

Potato Formula B.

Ingredients.		*Composition.*		
Nitrate of soda	192 pounds.	Nitrogen	6.5	per cent.
High grade dried blood	800 pounds.	Available phos. acid	4.9	per cent.
Acid phosphate	570 pounds.	Potash	10.1	per cent.
Sulphate of potash	400 pounds.			
Land plaster	38 pounds.			
	2000 pounds.			

Formula No. 3.—This formula is an imitation of the one so commonly followed by clubs of farmers on Long Island who purchase their fertilizers on the coöperative plan.

L. I. Formula A.

Ingredients.		*Composition.*		
Nitrate of soda	127 pounds.	Nitrogen	3.8	per cent.
High grade dried blood	440 pounds.	Available phos. acid	8.0	per cent.
Acid phosphate	1000 pounds.	Potash	10.4	per cent.
Muriate of potash	400 pounds.			
Land plaster	33 pounds.			
	2000 pounds.			

Formula No. 4.—This formula is similar to No. 3, except that the potash is supplied as the sulphate instead of the muriate.

L. I. Formula B.

Ingredients.		*Composition.*		
Nitrate of soda	127 pounds.	Nitrogen	4	per cent.
High grade dried blood	440 pounds.	Soluble phos. acid	8.4	per cent.
Acid phosphate	1000 pounds.	Potash	9.2	per cent.
Sulphate of potash	400 pounds.			
Land plaster	33 pounds.			
	2000 pounds.			

It was intended that approximately one-fourth of the nitrogen furnished by these mixtures should be nitric, and three-fourths organic nitrogen. The manufacturers who mixed the fertilizer were also instructed that the phosphoric acid should be as largely soluble as possible. The analyses of the four mixtures showed that these conditions were secured.

THE AREA AND ARRANGEMENT OF PLATS.

The total area under experimental treatment is eight acres, divided into eighty plats of one-tenth acre in size.

This area is distributed equally on four farms, the arrangement of the plats and amounts and kinds of fertilizers being the same in each case.

FERTILIZERS APPLIED ON PLATS.

Plat No. 1, no fertilizer.	Plat No. 11, no fertilizer.
Plat No. 2, 500 lbs., formula No. 1.	Plat No. 12, 500 lbs., formula No. 3.
Plat No. 3, 1000 lbs., formula No. 1.	Plat No. 13, 1000 lbs., formula No. 3.
Plat No. 4, 1500 lbs., formula No. 1.	Plat No. 14, 1500 lbs., formula No. 3.
Plat No. 5, 2000 lbs., formula No. 1.	Plat No. 15, 2000 lbs., formula No. 3.
Plat No. 6, no fertilizer.	Plat No. 16, no fertilizer.
Plat No. 7, 500 lbs., formula No. 2.	Plat No. 17, 500 lbs., formula No. 4.
Plat No. 8, 1000 lbs., formula No. 2.	Plat No. 18, 1000 lbs., formula No. 4.
Plat No. 9, 1500 lbs., formula No. 2.	Plat No. 19, 1500 lbs., formula No. 4.
Plat No. 10, 2000 lbs., formula No. 2.	Plat No. 20, 2000 lbs., formula No. 4.

LOCATION AND MANAGEMENT OF THE EXPERIMENT.

Land is leased of four farmers:

W. A. Fleet, Cutchogue; W. L. Jagger, Southampton; H. L. Hallock, Jamesport; R. H. Robbins, East Williston.

Arrangements have been made with Mr. Fleet to give general supervision to the experiments on all these farms; and with each farmer, to do the necessary work.

The following directions for conducting the experiments were placed in Mr. Fleet's hands:

DIRECTIONS FOR FIELD EXPERIMENTS WITH FERTILIZERS.

1. Select about two acres of land that is as uniform in character as possible, and which has received no manure for several years (run-out land if you have it).

2. Before the plats are laid out plow the whole piece, and pulverize thoroughly.

3. Make the size of each plat one-tenth of an acre.

4. Measure off the plats and drive permanent stakes at each corner, leaving a strip of land two feet wide between the plats. If the land is inclined, the length of the plats should be up and down the slope.

5. Number the plats from 1 to 20.

6. Put no fertilizer on plats 1, 6, 11 and 16, and no fertilizer on any plat except that contained in the bags.

7. Put the fertilizers on the plats numbered to correspond to the numbers on the bags. Put bag No. 2 on plat No. 2, etc., etc.

8. Apply the fertilizers in the method which you have practiced.

9. Make the same number of rows on each plat, with the same number of hills in each row if possible.

10. Put the same amount of the same kind of seed on each plat.

11. Plant the seed (or sow) on the same day on all the plats, if possible.

12. Cultivate the plats while the crop is growing, as nearly at the same time as possible.

13. Spray the crop as needed to prevent insect and fungous pests.

14. Weigh the crop carefully on each plat—both grain and straw if grain is sown, both corn and fodder if corn is planted (that is, find weight of grain and straw separately) or both large and small potatoes.

15. Carefully report any misfortune to the crop on any plat, and keep a record of the appearance of each plat.

CONDITIONS AFFECTING THE EXPERIMENTS.

These experiments were subject to certain unfortunate conditions which rendered the results on at least two farms of less value than otherwise would have been the case. In the first place the seed proved to be somewhat inferior and as a result the plants were tardy in establishing vigorous growth, being somewhat sickly in appearance at first. Later the dry weather, early blight and the rot also entered as disturbing factors. These several conditions, one or all combined, greatly diminished the accuracy of the data from the experiments on Mr. Robbins' and Mr. Jagger's farms, so that conclusions derived from Mr. Fleet's and Mr. Hallock's experiments are more reliable than the average results from the four farms. The following data are important:

Crop preceding the experimental crop.—Experiment of W. A. Fleet, corn stubble; H. L. Hallock, timothy sod; W. L. Jagger, timothy sod; R. H. Robbins, corn stubble.

Care of crop.—W. A. Fleet sprayed six times, H. L. Hallock five times, R. H. Robbins twice, and W. L. Jagger once. All the fields were well cultivated and kept free from weeds.

Growth of vines.—Vines weak at first, some hills missing. On July 3 vines green and healthy, excepting on farm of Mr. Robbins where they seemed to have about finished growing and were inclined to ripen.

August 7, vine growth improved, excepting on Robbins' field where the vines were about dead.

The fertilizers had a marked effect on the size of the vines. On the plats receiving 500 lbs. of fertilizer per acre they were 1½ to 2 times larger than on the plats with no fertilizer. Those from 1,000 lbs., 1,500 lbs. and 2,000 lbs. of fertilizers per acre did not differ in sizes and were about three times as large as on the unfertilized plats.

In one instance the vines from the "potato formula" were darker green than from the "L. I. formula" and in two other cases the "L. I. formula" caused the vines to grow one-fourth larger.

Prevalence of disease.—On Mr. Fleet's and Mr. Hallock's farms the vines were healthy with very little blight or rot. Either dry weather caused premature ripening of Mr. Robbins' potatoes or else the early blight killed the vines. Mr. Jagger's crop was badly affected by rot.

RESULTS OF THE EXPERIMENTS.

In order to answer the questions asked of this experiment, both the weight and composition of the product must be known. In the several tables of figures given herewith can be found a statement of the yield of potatoes from the different mixtures and amounts of fertilizers and also the content in dry matter, starch and the important plant food constituents of the potatoes grown by Messrs. Fleet and Hallock.

Table I. Yield of potatoes on tenth acre plats.

Table II. Average yield of potatoes per acre from different amounts of fertilizer.

Table III. Partial composition of potatoes.

TABLE I.—YIELD OF POTATOES ON ONE-TENTH ACRE PLATS.

FERTILIZER.	No. of plat.	Amount of fertilizer per acre.	Potatoes on Plats on Farms of											
			William A. Fleet.			H. L. Hallock.			W. L. Jagger.			R. H. Robbins.		
			Large.	Small.	Total.	Large.	Small.	Total.	Large.	Small.	Total.	Large.	Small.	Total.
		Formula 1. Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Potato formula A	1	0	559	77	636	311	277	588	93	55	148	504	62	566
	2	500	698	79	777	453	274	727	178	115	293	520	66	586
	3	1,000	884	70	954	650	214	864	207	84	291	401	70	471
	4	1,500	1,085	78	1,163	676	120	796	363	131	494	501	85	586
	5	2,000	1,082	78	1,160	595	247	762	257	96	353	449	70	519
		Formula 2.												
Potato formula B	6	0	544	94	638	235	233	468	115	67	182	452	60	512
	7	500	772	75	847	415	247	662	180	90	270	430	90	520
	8	1,000	1,067	82	1,149	773	248	1,021	171	91	262	411	128	539
	9	1,500	1,165	71	1,236	687	122	809	225	94	319	523	102	625
	10	2,000	1,188	80	1,268	810	284	1,094	207	56	263	386	72	458
		Formula 3.												
L. I. formula A	11	0	713	105	818	367	317	684	39	32	71	456	70	526
	12	500	980	119	1,099	570	230	800	137	96	233	618	81	699
	13	1,000	1,035	132	1,167	790	199	989	219	131	350	674	88	762
	14	1,500	1,176	100	1,276	701	233	934	258	125	383	713	90	803
	15	2,000	1,180	123	1,303	813	156	969	320	129	449	753	68	821
		Formula 4.												
L. I. formula B	16	0	767	179	946	396	254	650	137	140	277	507	65	572
	17	500	1,005	136	1,141	656	237	893	214	133	347	697	81	778
	18	1,000	1,140	88	1,228	870	180	1,050	275	124	399	715	80	795
	19	1,500	1,170	91	1,261	953	125	1,078	287	108	395	718	92	810
	20	2,000	1,080	81	1,161	1,004	135	1,139	300	96	396	661	73	734

TABLE II.—AVERAGE YIELD OF POTATOES PER ACRE FROM DIFFERENT AMOUNTS OF FERTILIZER.

EXPERIMENTER.	No. of plats averaged.	Yield of Potatoes With														
		No fertilizer.			500 lbs. fertilizer.			1,000 lbs. fertilizer.			1,500 lbs. fertilizer.			2,000 lbs. fertilizer.		
		Large.	Small.	Total.	Large.	Small.	Total.	Large.	Small	Total.	Large.	Small.	Total.	Large.	Small.	Total.
		Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.
Wm. A. Fleet......	4	107.7	18.9	126.6	144	17	161	171.9	15.5	187.4	191.5	14.2	205.7	188.7	15.1	203.8
H. L. Hallock......	4	54.5	45	99.5	87.2	41.2	128.4	128.5	35	163.5	125.7	25	150.7	130.9	32.2	165.1
W. L. Jagger	4	16	12.2	28.2	29.2	18.1	47.6	36.3	17.9	54.2	47.2	19.1	66.3	45.1	15.7	60.8
R. H. Robbins......	2	81.9	11.2	93.1	109.6	13.5	123.1	115.8	14	129.8	119.2	15.2	134.4	117.8	11.7	129.5
Average of all..	14	65	21.8	86.8	92.5	22.5	115	113.1	20.6	133.7	120.9	18.4	139.3	120.6	18.7	139.8
Average increase of yield	....	....	......	....	27.5	......	28.2	48.1	......	46.9	55.9	......	52.5	55.6	......	53
Average yield, Fleet & Hallock.......	8	81.1	32	113.1	115.6	29.1	144.7	150.2	25.2	175.4	158.6	19.6	178.2	159.8	23.6	184.4
Average increase, Fleet & Hallock..	....	....	......	......	34.1	......	31.6	69.1	......	62.3	77.5	......	65.1	78.7	......	71.3

TABLE III — PARTIAL COMPOSITION OF THE POTATOES.

Laboratory number.	Number of plat.	AMOUNT PER ACRE AND KIND OF FERTILIZER.	FRESH MATERIAL.						WATER-FREE MATERIAL.			
			Water.	Dry matter.	Starch.	N.	P_2O_5.	K_2O.	Starch.	N.	P_2O_5.	K_2O.
		Formula 1.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
329	1	No fertilizer	81.13	18.87	13	0.34	0.111	0.39	68.9	1.81	0.588	2.06
330	2	500 pounds—potash as muriate	79.43	20.57	14.1	.33	.195	.42	68.7	1.61	.463	2.02
331	3	1,000 pounds—potash as muriate...	80.25	19.75	14	.31	.097	.41	70.9	1.57	.493	2.09
332	4	1,500 pounds—potash as muriate...	82.13	17.87	12.1	.33	.100	.49	67.5	1.82	.559	2.72
333	5	2,000 pounds—potash as muriate...	80.97	19.03	13.3	.31	.092	.36	69.8	1.61	.485	1.92
		Formula 2.										
334	6	No fertilizer	80.24	19.76	14.4	.33	.117	.37	73	1.68	.594	1.89
335	7	500 pounds—potash as sulphate....	78.98	21.02	15.7	.33	.117	.40	74.8	1.59	.555	1.89
336	8	1,000 pounds—potash as sulphate ..	79.78	20.22	14.9	.34	.103	.39	73.8	1.66	.508	1.93
337	9	1,500 pounds—potash as sulphate ..	80.01	19.99	14 6	.33	.099	.43	72.8	1.66	.497	2.13
338	10	2,000 pounds—potash as sulphate ..	80.45	19.55	13.9	.34	.102	.48	71.2	1.73	.522	2.44
		Formula 3.										
339	11	No fertilizer	80.85	19.15	13.5	.32	.114	.40	70.5	1.65	.597	2.11
340	12	500 pounds—potash as muriate.....	79.55	20.45	15.4	.30	.099	.42	75.5	1.48	.484	2.07
341	13	1,000 pounds—potash as muriate...	80.83	19.17	13.4	.30	.091	.46	69.7	1.57	.489	2.42
342	14	1,500 pounds—potash as muriate...	82.44	17.56	11.8	.30	.083	.52	67.2	1.72	.474	2.98
343	15	2,000 pounds—potash as muriate...	82.33	17.67	11.8	.35	.107	.52	66.8	1.97	.604	2.97
		Formula 4.										
344	16	No fertilizer.	78.53	21.47	16.2	.35	.109	.41	75.6	1.62	.507	1.90
345	17	500 pounds—potash as sulphate....	78.88	21.12	15.7	.32	.103	.43	74.5	1.51	.488	2.04
346	18	1,000 pounds—potash as sulphate..	78.31	21.69	16.3	.31	.104	.45	75.3	1.44	.480	2.06
347	19	1,500 pounds—potash as sulphate ..	79.14	20.86	15.2	.33	.107	.43	72.7	1.59	.511	2.06
348	20	2,000 pounds—potash as sulphate ..	79.58	20.42	14.3	.33	.106	.37	70	1.63	.517	1.82

TABLE III. — PARTIAL COMPOSITION OF THE POTATOES — (*Continued*).

Laboratory number.	Number of plat.	AMOUNT PER ACRE AND KIND OF FERTILIZER.	Fresh Material.						Water-Free Material.			
			Water.	Dry matter.	Starch.	N.	P_2O_5.	K_2O.	Starch.	N.	P_2O_5.	K_2O.
		Formula 1.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
349	1	No fertilizer	80.17	19.83	13.4	0.29	0.122	0.57	67.4	1.48	0.613	2.88
350	2	500 pounds—potash as muriate	80.29	19.71	13.3	.30	.116	.54	67.7	1.52	.591	2.72
351	3	1,000 pounds—potash as muriate	79.98	20.02	14.9	.29	.111	.53	74.6	1.43	.555	2.65
352	4	1,500 pounds—potash as muriate	79	21	14.8	.35	.119	.62	70.5	1.65	.566	2.94
353	5	2,000 pounds—potash as muriate	81.30	18.70	12.9	.31	.110	.55	68.8	1.66	.588	2.94
		Formula 2.										
354	6	No fertilizer	79.27	20.73	15	.26	.126	.58	72.5	1.28	.610	2.78
355	7	500 pounds—potash as sulphate	80.25	19.75	13.9	.29	.118	.54	70.6	1.47	.599	2.74
356	8	1,000 pounds—potash as sulphate	80.04	19.96	14.7	.31	.115	.54	73.5	1.55	.576	2.70
357	9	1,500 pounds—potash as sulphate	80.29	19.71	14	.32	.114	.58	70.8	1.62	.576	2.96
358	10	2,000 pounds—potash as sulphate	79.45	20.55	14.9	.31	.108	.57	72.4	1.50	.526	2.97
		Formula 3.										
359	11	No fertilizer	79.95	20.05	14.5	.30	.114	.54	72.4	1.51	.568	2.72
360	12	500 pounds—potash as muriate	79.72	20.28	15	.27	.113	.59	74.2	1.31	.555	2.92
361	13	1.000 pounds—potash as muriate	79.50	20.50	15.3	.26	.105	.56	74.8	1.28	.514	2.73
362	14	2,000 pounds—potash as muriate	80.72	19.28	14	.25	.105	.57	72.6	1.32	.544	2.98
363	15	1,500 pounds—potash as muriate	80.41	19.59	14.5	.28	.106	.56	73.8	1.41	.539	2.86
		Formula 4.										
364	16	No fertilizer	78.76	21.24	15.4	.28	.113	.54	76.4	1.33	.531	2.56
365	17	500 pounds—potash as sulphate	79.08	20.92	16.1	.30	.117	.56	76.9	1.43	.558	2.70
366	18	1,000 pounds—potash as sulphate	78.67	21.33	16.4	.30	.115	.56	79	1.39	.538	2.62
367	19	1,500 pounds—potash as sulphate	78.75	21.25	16	.30	.109	.55	78	1.42	.512	2.57
368	20	2,000 pounds—potash as sulphate	78.64	21.36	16.2	.30	.100	.68	79	1.41	.467	3.20

RELATION OF YIELD OF POTATOES TO THE AMOUNT OF FERTILIZER APPLIED.

The figures given below show the average results from all the experiments, and also from the two experiments, that, because of the freedom of the vines and tubers from disease, and other favorable conditions, proceeded in the most satisfactory manner.

TABLE IV.—INCREASE OF YIELD FROM DIFFERENT QUANTITIES OF FERTILIZERS.

NUMBER OF PLATS AVERAGED.		Amount of fertilizer per acre.	AVERAGE OF ALL EXPERIMENTS.		AVERAGE OF FLEET AND HALLOCK.	
All experiments.	Fleet and Hallock.		Increase large tubers.	Total increase.	Increase large tubers.	Total increase.
		Pounds.	Bushels.	Bushels.	Bushels.	Bushels.
14	8	500	27.5	28.2	34.1	31.6
14	8	1,000	48.1	46.9	69.1	62.3
14	8	1,500	55.9	52.5	77.5	65.1
14	8	2,000	55.6	53	78.7	71.3

These figures show very plainly that an addition of fertilizers above 1,000 lbs. per acre produced a very small increase of crop. The first 500 lbs. caused a marked increase of yield, as also did the second. Moreover, the rate of production was proportionate to the quantity of fertilizer used up to 1,000 lbs. per acre. The crop from 1,500 lbs. of fertilizer was somewhat larger than from 1,000 lbs., but not enough so to warrant the extra expenditure, as will be seen later. The production of merchantable tubers with 2,000 lbs. of fertilizer was practically the same as with 1,500 lbs.

RELATIVE YIELD FROM THE POTATO FORMULA AND THE LONG ISLAND FORMULA.

The "potato" formula is supposed to supply the important elements of plant food in the proportions and amounts needed by the entire plant for a profitably large crop. The Long Island formula is the 4–8–10 fertilizer so largely in use by Long Island farmers.

It is interesting to note the relative yields from these two mixtures, the essential differences between which is that the former contains much more nitrogen and much less phosphoric acid than the latter, the potash being the same.

TABLE V.—RELATIVE YIELD FROM POTATO FORMULA AND LONG ISLAND FORMULA.

AMOUNT OF FERTILIZER PER ACRE.	Average of Three Experiments.			Average of Fleet and Hallock.		
	Potato formula.	Long Island formula.	Excess from Long Island formula.	Potato formula.	Long Island formula.	Excess from Long Island formula.
	Bushels.	Bushels.	Bushels.	Bushels.	Bushels.	Bushels.
None	84.8			113.1		
500 pounds..	99.3	125.3	26.	125.5	163.8	38.3
1,000 pounds..	126.1	143.9	17.8	166.2	184.7	18.5
1,500 pounds..	133.8	147.9	14.1	166.8	189.5	22.7
2,000 pounds..	136.	150.4	14.4	178.4	190.4	12.
Average	123.8	141.9	18.1	159.2	182.1	22.9

The foregoing table of averages shows that there was a uniform and material difference in favor of the Long Island formula. As before noted the vines were reported as one-fourth larger from this mixture than from the other. The excess of crop from the Long Island formula seems to be greatest where the smallest amounts of fertilizer were applied, which may indicate either that the small application of the "potato" formula did not furnish the profitable maximum of phosphoric acid or that the large applications contained an undesirable quantity of nitrogen compounds. In either case, if future experiments substantiate the results for 1897, the claim that the composition of a crop should be the guide for mixing special fertilizers will be discredited.

THE FINANCIAL SIDE OF THE EXPERIMENTS.

The potatoes from these experimental fields were sold at 75 cents per bushel for large (merchantable) and 25 cents for small, and the money values found in the following table are calculated from these prices.

TABLE VI.—FINANCIAL SIDE OF THE EXPERIMENTS.

Average of All.

AMOUNT OF FERTILIZER PER ACRE.	Acre value total crop.	Value increase from each 500 pounds fertilizer added.	Bushel cost of potatoes from each 500 pounds fertilizer added.
	Dollars.	Dollars.	Dollars.
None	54.20	....	....
500 pounds	75.00	20.80	0.22
1,000 "	89.97	14.97	0.33
1,500 "	95.27	5.30	1.12
2,000 "	95.15	....	....

Average Hallock and Fleet Farms.

	Dollars.	Dollars.	Dollars.
None	68.82	....	....
500 pounds	93.95	25.13	0.20
1,000 "	118.95	25.00	0.20
1,500 "	123.85	4.90	2.23
2,000 "	125.75	1.90	1.01

NOTE.—The cost of the fertilizer is assumed to be $25,00 per ton.

It is evident that if we consider the first year's crop only the application of one ton of fertilizer per acre, or even 1,500 pounds, was considerably less profitable than the use of 1,000 pounds. The fertilizer cost of the small increase of product caused by applying more than 1,000 pounds of fertilizer was much greater than the market value of the potatoes, even in this year of good prices.

On the other hand the use of 1,000 pounds was very profitable, the fertilizer cost of the increased yield on the Fleet and Hallock farms being only 20 cents per bushel. Even if the merchantable potatoes had been sold at 40 cents per bushel, there would still be a reasonable margin of profit. It should be kept in mind that these figures refer to the light soils and market conditions of Long Island.

THE INFLUENCE OF THE POTASH SALTS UPON THE COMPOSITION OF THE POTATO.

Much investigation has been carried on to determine whether a liberal application of muriate of potash has a depressing effect upon the proportion of dry matter and starch in the potato. The

testimony so far secured is conflicting. In many cases the quality of the tubers as expressed by the percentages of dry matter and starch has been found to be lower with the use of the muriate than where the sulphate was applied. In a recent number of *Die landwirtschaftlichen Versuchs-Stationen*, Pfeiffer and others review the data bearing upon this point and give results from well-planned experiments of their own. Their conclusions are that the muriate free from other compounds has no injurious effect upon the composition of the potato tuber, but that the depression in the proportion of starch which has been noticed is due to the impurities in the commercial potash salts, notably magnesium chloride. These authors even claim that the addition of chlorine to the soil may under some circumstances be beneficial to the quality of the tubers.

THE PROPORTION OF DRY MATTER AND STARCH.

About one bushel of potatoes was sent to the Station from each one of the experimental plats on the Hallock and Fleet farms. Tubers to the amount of about ten pounds were carefully selected from each lot, were sliced and dried at a temperature between 50° and 60° C. Determinations were made in each sample of the dry matter, starch, nitrogen, phosphoric acid and potash. These results are given in detail in Table III and are summarized in the succeeding tables, Nos. VII, VIII and IX.

TABLE VII.—INFLUENCE OF THE POTASH COMPOUNDS UPON THE AMOUNT OF DRY MATTER IN THE POTATO.

AMOUNT OF FERTILIZER PER ACRE.	HALLOCK'S FARM.			FLEET'S FARM.			Average of both farms.
	Potato formula.	Long Island formula.	Average.	Potato formula.	Long Island formula.	Average.	
Potatoes grown with Muriate of Potash.—Plats 1–5 and 11–15.							
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
None	18.87	19.15	19.01	19.83	20.05	19.94	19.47
500 pounds	20.57	20.45	20.51	19.71	20.28	19.99	20.25
1,000 pounds	19.75	19.17	19.46	20.02	20.50	20.26	19.86
1,500 pounds	17.87	17.56	17.72	21	19.28	20.14	18.93
2,000 pounds	19.03	17.57	18.35	18.70	19.59	19.14	18.74
Averages fertilized plats	19.35	18.71	19	19.86	19.91	19.88	19.45
Potatoes grown with Sulphate of Potash.—Plats 6–10 and 16–20							
None	19.76	21.47	20.61	20.73	21.24	20.98	20.80
500 pounds	21.02	21.12	21.07	19.75	20.92	20.33	20.70
1,000 pounds	20.22	21.69	20.95	19.96	21.33	20.64	20.80
1,500 pounds	19.99	20.86	20.42	19.71	21.25	20.48	20.46
2,000 pounds	19.55	20.42	19.99	20.55	21.36	20.95	20.47
Averages fertilized plats	20.19	21.02	20.6	20	21.21	20.60	20.61

TABLE VIII.—INFLUENCE OF THE POTASH COMPOUNDS UPON THE AMOUNT OF STARCH IN THE POTATO.

AMOUNT OF FERTILIZER PER ACRE.	Hallock Farm.			Fleet Farm.			Average, both farms.
	Potato formula.	Long Island formula.	Average.	Potato formula.	Long Island formula.	Average.	
Potatoes grown with Muriate of Potash.—Plats 1–5 and 11–15.							
	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
None	13	13.5	13.2	13.4	14.5	13.9	13.5
500 pounds	14.1	15.4	14.7	13.3	15	14.1	14.4
1,000 pounds	14	13.4	13.7	14.9	15.3	15.1	14.4
1,500 pounds	12.1	11.8	11.9	14.8	14	14.4	13.1
2,000 pounds	13.3	11.8	12.6	12.9	14.5	13.7	13.1
Average fertilized plats	13.4	13.1	13.2	14	14.7	14.3	13.7
Potatoes grown with Sulphate of Potash.—Plats 6–10 and 16–20.							
None	14.4	16.2	15.3	15	15.4	15.2	15.2
500 pounds	15.7	15.7	15.7	13.9	16.1	15	15.3
1,000 pounds	14.9	16.3	15.6	14.7	16.4	15.5	15 5
1,500 pounds	14.6	15.2	14.9	14	16	15	14.9
2,000 pounds	13.9	14.3	14.1	14.9	16.2	15.5	14.8
Average fertilized plats	14.8	15.4	15.1	14.4	16.2	15.3	15.2

Table IX—Proportions of the Important Elements of Plant-Food in the Fresh Tubers.

	Nitrogen.		Phosphoric Acid.		Potash.	
	With KCl.	With K_2SO_4.	With KCl.	With K_2SO_4.	With KCl.	With K_2SO_4.
	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
None	0.31	0.30	0.116	0.116	0.47	0.47
500 pounds	.30	.30	.106	.113	.49	.48
1,000 pounds	.28	.31	.101	.109	.49	.48
1,500 pounds	.31	.32	.097	.107	.54	.49
2,000 pounds	.31	.32	.107	.104	.49	.52
Averages	.30	.31	.105	.110	.50	.49
	.30		.107		.49	

A still briefer summary of the percentages of dry matter and starch is the following:

Dry Matter and Starch in Potatoes Differently Fertilized.

	Plats with Muriate of Potash.		Plats with Sulphate of Potash.	
	Dry matter.	Starch.	Dry matter.	Starch.
	Per cent.	Per cent.	Per cent.	Per cent.
Averages 16 plats	19.45	13.7	20.61	15.2
Averages adjacent plats not fertilized	19.47	13.5	20.80	15.2

The potatoes produced where the sulphate of potash was added contained both more dry matter and more starch than did the potatoes grown where the muriate was used. As these figures are an average of 16 plats for each manner of treatment they would seem to be significant. Their force is diminished greatly, however, by the fact that the adjacent plats receiving no fertilizer differed in the same way and to the same extent. It would not be safe, therefore, to conclude from these data that the muriate is inferior to the sulphate of potash for potato growing.

The Utilization of Plant Food.

It has been noticed in some cases that the percentages of certain plant food compounds taken up by a crop are increased by liberal manuring. This does not seem to be the case in these experiments as the figures in Table IX clearly show. Neither the kind nor the amount of fertilizer applied caused noticeable variation in the percentages of nitrogen, phosphoric acid and potash found in the tubers.

METEOROLOGICAL RECORD

FOR

1897.

PRECIPITATION BY MONTHS SINCE 1882.

YEARS.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
	In.	In.	In.	In	In.	In.	In.	In.	In.	In.	In.	In.	In.
1882	.....	......	......	......	......	3.69	2.42	2.37	1.25	0.62	1.22	0.55	....
1883	0.48	1.44	0.88	1.58	4.45	4.12	2.98	3.47	2.12	2.10	1.54	0.73	25.89
1884	1.83	2.01	2.54	0.83	2.49	2 01	2.33	1.44	3.17	1.67	1.01	0.97	22.30
1885	1.07	0.61	0.12	1.26	1.58	2.49	4.64	5.02	2.11	2.88	1.36	0.76	23.90
1886	1.13	0.95	1.13	4.13	1.92	2.92	4.41	2.86	2.31	1.39	3.48	1.24	27.87
1887	0.18	2.17	0.48	1.37	0.46	2.01	6 37	3.03	0.75	1.74	1.58	1.35	22.29
1888	0.78	1.04	1.43	3.09	2.79	3.88	0.99+	4.02	2.73	3.47	2.02	1.24+	27.48
1889	2.99+	0.25	0.66+	3.28	1.21	7.47	4.57	1.98	2.50	3.32	3.44	1.62	32.28
1890	2.16	1.45	2.16	2.20	5.49	5.26	1.07	4.34	5.81	4.54	2.40	......	36.88
1891	1.44	1.57	3.25	1.63	0.49	4.31	3.52	3.16	0.47	3 65	0.74	3.29	27.52
1892	0.57	0.88	0.55	0.67	4.04	3.95	1.89	4.77	1.12	1.34	2.67	0.72	23.17
1893	1.62	3 71	1.94	2.59	4.92	3.08	3.68	5.38	2.68	1.59	1.09	1.56	33.84
1894	2.21	2.71	1.36	2.43	7.03	1.77	1.50	1.22	4.61	3.59	0.43	0.47	29.36
1895	0.96	0.00	0.29	1.33	2.88	......	......	2.66	0.94	0.72	2.31	2.49	....
1896	1.19	2.28	0.84	0.41	2.31	3.71	4.12	3.33	4.27	2.26	2.18	0.71	27.61
1897	0.64	0.21	2.12	1.90	2.19	3.16	5.28	1.27	2.36	0.73	2.53	1.39	23.78

WIND RECORD FOR 1897.

	January.				February.				March.				April.			
	Northerly, N. W. to N. E.	Easterly, N. E. to S. E.	Southerly, S. E. to S. W.	Westerly, S. W. to N. W.	Northerly, N. W. to N. E.	Easterly, N. E. to S. E.	Southerly, S. E. to S. W.	Westerly, S. W. to N. W.	Northerly, N. W. to N. E.	Easterly, N. E. to S. E.	Southerly, S. E. to S. W.	Westerly, S. W. to N. W.	Northerly, N. W. to N. E.	Easterly, N. E. to S. E.	Southerly, S. E. to S. W.	Westerly, S. W. to N. W.
	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.
1			20				20				19		18			6
2			24		11		5			6	3	12	6			17
3			24		21			3			12	12	17			
4			17	5	2			10			4	18		11	12	
5			3	12			22				22	2			17	6
6				24		11	13		14	1		9	1			22
7				21		4	3	17	6	14			13			6
8		6	12					24			24		8		8	
9			12	6				24			24		6	11		2
10				24	15			4			9	15				24
11				24	6	12				3	2	16				21
12				24		20		3		2	11	10		8		15
13		8	2	6	2	3	2	13	3	4		17			24	
14	11		4				12	12		5	9	10			1	22
15	4					6	2	5				24				18
16			7	7				18	13			8			11	11
17			23	1			12	11		3	9					17
18				24				24			20				7	17
19	5			11				24		13	1				10	14
20			24				17	6	2		13	9				20
21			10	14	1		6	17	3			16		9	7	2
22			7	13	7	8	9			8		6			24	
23				24			2	21	6	6		10		1	15	6
24				24			4	18				17			1	12
25				24			11	13				24			9	15
26				24			1	19				24			5	19
27				13			1	23				24				24
28				24	5			17	4			20	5			13
29				24								11	2	9	5	
30				24					5	3			2	1	2	
31			14	7					11			3				
Total hours of movement	20	14	203	404	70	64	142	326	67	68	182	317	78	50	158	329
Per cent of time in each direction	3.1	2.2	31.7	63	11.6	10.6	23.6	54.2	10.6	10.7	28.7	50	12.7	8.1	25.7	53.5

WIND RECORD — (*Continued*).

	May.				June.				July.				August.			
	Northerly, N. W. to N. E.	Easterly, N. E. to S. E.	Southerly, S. E. to S. W.	Westerly, S. W. to N. W.	Northerly, N. W. to N. E.	Easterly, N. E. to S. E.	Southerly, S. E. to S. W.	Westerly, S. W. to N. W.	Northerly, N. W. to N. E.	Easterly, N. E. to S. E.	Southerly, S. E. to S. W.	Westerly, S. W. to N. W.	Northerly, N. W. to N. E.	Easterly, N. E. to S. E.	Southerly, S. E to S. W.	Westerly, S. W. to N. W.
	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.
1		11	13					24				7	2			15
2		20	2	2		11	2	10		1				7	1	
3	6			14			12	8		2	11			4	8	2
4	1			15	3			17			23			4	3	2
5	11			11	2	2	4	6	1	16		5		6	8	
6	10						16		6			11			7	
7	13			3			23		13			4		6	2	
8		6	3	4			17			3	9				21	
9			11	2		5	2	1		3	6	4		4	10	
10				23	1			18	2	5	7	3		3	8	1
11			15	4				15			16	4	1			16
12			12	8				22	7			9				22
13		1	9	5	1			21	6			8				20
14			10	12				24	1			17			10	
15	4		1	14	3			15	2			9		2	15	
16	6			4	2		8	10		3	9				6	17
17			8	7	9			2		7	6					20
18	1			19	6	1		5		10	5				5	13
19	7	11	2	2		3	3	3		3	13				1	12
20			13	11	2			21			16		3			18
21	4			20				24			22			1	1	9
22				17			5	12			7	14	8			5
23			19	3			11	7	1		4	16	6	4		4
24	3		7	5		6	12					24			1	5
25				18				22	6			12			8	16
26	10			7	3			20		14		1				18
27	3			21				20		20	4				16	5
28				16	2			8		6	16					16
29				23		8	4			3	2				16	5
30		3	13	2	3			16	1		2	13	4			18
31			1	23							2	22	2			15
Total hours of movement	79	52	139	315	37	36	119	351	46	96	180	183	26	41	147	274
Per cent of time in each direction	13.5	8.8	23.8	53.9	6.8	6.7	21.9	64.6	9.1	19	35.7	36.2	5.3	8.4	30.1	56.2

WIND RECORD — (*Concluded*).

	SEPTEMBER.				OCTOBER.				NOVEMBER.				DECEMBER.			
	Northerly, N. W. to N. E.	Easterly, N. E. to S. E.	Southerly, S. E. to S. W.	Westerly, S. W. to N. W.	Northerly, N. W. to N. E.	Easterly, N. E. to S. E.	Southerly, S. E to S. W.	Westerly, S. W. to N. W.	Northerly, N. W. to N. E.	Easterly, N. E. to S. E.	Southerly, S. E. to S. W.	Westerly, S. W. to N. W.	Northerly, N. W. to N. E.	Easterly, N. E. to S. E.	Southerly, S. E. to S. W.	Westerly, S. W. to N. W.
	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.	Hrs.
1	5	2	2	5	9	...	...	8	1	5	7	...	...	...	14	9
2	9	...	...	5	8	10	3	...	...	...	...	9	...	...	...	5
3	7	1	...	...	...	4	7	...	...	...	...	22	...	11	2	...
4	...	3	6	2	...	...	16	...	...	...	11	1	...	8	13	...
5	1	...	...	13	...	...	24	...	...	...	24	...	...	...	1	21
6	1	1	1	...	...	...	4	18	...	...	3	21	1	5	6	...
7	2	9	1	...	9	...	...	...	...	...	...	18	...	...	15	7
8	2	1	3	1	...	...	16	...	...	3	4	3	...	...	14	...
9	...	...	1	10	...	...	1	21	...	...	3	13	...	...	19	...
10	...	...	...	14	...	8	6	2	...	...	...	17	...	...	24	...
11	10	...	...	4	...	...	24	...	...	...	13	5	...	...	10	14
12	1	10	5	...	...	...	10	13	...	...	...	24	3	...	...	18
13	...	...	9	15	...	...	...	8	...	...	...	24	4	10	...	4
14	18	...	...	...	...	...	17	...	...	5	4	9	...	15	4	...
15	...	5	3	...	...	...	9	13	...	...	24	...	...	...	...	18
16	...	...	12	11	...	...	...	24	...	...	9	15	...	...	4	20
17	8	...	...	10	10	...	...	14	...	...	...	22	...	3	5	8
18	...	...	1	12	...	3	4	4	...	...	...	18	...	...	...	24
19	...	...	6	6	...	2	9	...	...	...	14	...	6	...	...	5
20	3	...	...	15	...	3	12	...	...	...	22	...	...	9	10	...
21	...	...	...	17	...	...	11	...	...	...	9	15	...	...	...	14
22	...	7	6	...	...	...	15	...	4	7	...	...	...	...	...	10
23	...	10	2	...	...	4	3	...	...	...	...	23	...	...	...	19
24	...	...	...	12	3	3	...	...	...	...	11	10	...	...	...	21
25	...	...	...	21	5	...	...	8	...	...	24	...	...	...	13	7
26	3	...	...	21	1	...	...	2	...	...	21	3	...	...	...	11
27	...	...	...	13	...	2	10	...	3	...	...	13	...	...	...	24
28	...	...	2	8	...	...	14	7	...	7	7	2	...	...	6	8
29	...	4	3	1	...	...	...	24	...	...	12	12	...	...	18	2
30	...	...	6	10	...	...	1	14	...	...	...	23	...	...	1	23
31	...	...	...	...	...	...	23	...	...	...	...	...	10	...	...	7
Total hours of movement	70	53	69	226	40	39	239	180	8	27	222	322	24	61	179	302
Per cent of time in each direction	16.7	12.7	16.5	54.1	8	7.8	48	36.2	1.4	4.7	38.3	55.6	4.2	10.8	31.6	53.4

SUMMARY OF DIRECTION OF WIND FOR 1897.

	Northerly, N. W. to N. E.	Easterly, N. E. to S. E.	Southerly, S. E. to S. W.	Westerly, S. W. to N. W.	Total.
	Hours.	Hours.	Hours.	Hours.	Hours.
January	20	14	203	404	641
February	70	64	142	326	602
March	67	68	182	217	634
April	78	50	158	329	615
May	79	52	139	315	585
June	37	36	119	351	543
July	46	96	180	183	505
August	26	41	147	274	488
September	70	53	69	226	418
October	40	39	239	180	498
November	8	27	222	322	579
December	24	61	179	302	566
Total hours of movement	565	601	1,979	3,529	6,674
Per cent of time in each direction	8.5	9	29.6	52.9	....

READINGS OF THE STANDARD AIR THERMOMETER.

1897.	January.			February			March.			April.			May.			June.		
	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.
1	29	39	40	17	30	27	11	21.5	31.5	32	46.5	41	60	66.5	61	46.5	49.5	55
2	38	43	40	22	31	26	27	26.5	25	35	55.5	49	56	63	60	50	63	65
3	39	51.5	47	23	27	24	40	45	31	32	45	40	45	57	50	63.5	76	72
4	54	56	44	22	33	25	23.5	26.5	30	39	50	46.5	47	51	50	63	66.5	61
5	31	37	34	21	33	35	33	40	43	48	64	51	43	62	62	57	68.5	66
6	16	25	25	33	38	42	30	20	18	46	48	46	47	56	54	60	75	70
7	24	28.5	25	37	37	36	12	25	27	37	41	36	45	52.5	50	63	66	62
8	19	30	24	33	33	32	28	39	37	36	46	40	44	59	59	52	56.5	55.5
9	17	33	36	28	33	30	36	40	41	34	40	37	52	76	74	55	59.5	56
10	33	35	31	18	19	14	42.5	38	38	30.5	35	36	64	56.5	63	54.5	61.5	65
11	26	29.5	25	11	20	19	36	44	40	32	40	39	53	70	70	63.5	76	73
12	12	12	9	21	22	22	42	50.5	35	35	51	49	58	65.5	67	56	66	67
13	9	16	14	14	23	18	18	22.5	23	44	55.5	50	55	58	60	64	73	70
14	6	21	16	23	38	38	29	36	32	46	44	44	56	63	56	63	73	70
15	17	26	26	29	32	29.5	22	29	27	39	39	44	46	54	56	65	78	69.5
16	28	35	35	30	35	32	16	21	19	43	55	51	51	61	56	61	72	65
17	35	39	40	32	47	35	17	36	37	41	45.5	41	49	65	63	57	73	61
18	31	25	14	31.5	34	33	37	46	43	38	59	61	54	73.5	68	62	73	71
19	3.5	7	1	26	29	29	41	51	49.5	52.5	35	24.5	48	62	62	60.5	78	75
20	8.5	24	25	19	32	31.5	44.5	57	55	20.5	30	33	63	77	68	58.5	65	57
21	37	35	33	38	42	34.5	41	41.5	47	31	50	54	51	46	51	53	63	63
22	23	30	31	26	31	38	31	53	43	46	68	66	46	61	61	55	75	74
23	24	22	15	35	32	30	35	51	41	53.5	73.5	65	61	75	59	65	81	74
24	11	14.5	5	20	27	29	40	37	38	55	69	69	57	68	54	73	86	76.5
25	3	11	7.5	27	35	24	29	31.5	29	56.5	80	55	45.5	46	50	69	77.5	68
26	13	16	12	12	15	12	28	33.5	31	45	59	44	46	57	56	57.5	64	68
27	13	18	16	9.5	16.5	15	28	32	33	32	45	40	50	60.5	61	59	70	67
28	11	12.5	11	14.5	15	12	29	36	35	43	57	56	55	60	54	58	77	70
29	19	23	18	......	......	......	30	45	42	47	66	62	46.5	55	56	61	71	64
30	16.5	22	17	......	......	......	35	54	40	48	54	53	50	60	57	64	64	72
31	6	24	19	......	......	......	34	45	40	......	......	......	53	61	55	......	......	......
Average	21.1	27.1	23.7	24.0	30.0	27.6	30.5	38.0	35.5	40.6	51.6	47.4	51.5	61.2	58.8	59.7	69.9	66.6

READINGS OF THE STANDARD AIR THERMOMETER — (*Concluded*).

	July.			August.			September.			October.			November.			December.		
	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.
1	66	80.5	75	64	71	71	63	71	61	57	81	63	49	51	50.5	24	30	30.5
2	68	76	78	62	79	77	60	71	66.5	50	61	57	46	46.5	46	10.5	30	24
3	70	87	84	67	85.5	84	53	68	61	40	60.5	57	42	46.5	47	26	27	27
4	75	87.5	87	70	81	72.5	51	73.5	68	38	67	63	39.5	61	51	32	38	40
5	77	91.5	81	63.5	73	70	57	85	81	46	71.5	66	46	60	57	34	33	32.5
6	74	83	82	63	79.5	75	60	86	79	57	58	55	48.5	43	41.5	22	27.5	30
7	73.5	89	82	61	82	77	64	73	75	48	45	44	40	46	42	33	37	36
8	73	90	89	67	80	75	63	84	77	35	55	54	37	42	45.5	34	40	38
9	77	93	83	65.5	78.5	75.5	63	92	85	46	49	42	41.5	53	35	38	54	48.5
10	76	95.5	92	67	75	73	69.5	95.5	88	32	55	52	36	46	38.5	48.5	56	54
11	76	92.5	69	67	71	71	66	67	63.5	57.5	67	65	39	46	41	53	60	44.5
12	65	65	65	59	77	63	51.5	77	72.5	67	62	62	34.5	37.5	33.5	35.5	37.5	35
13	63	71	77	57	71.5	74	67	70	76	44	59	52	32	34	34.5	34	40	37
14	64	75.5	70	61.5	87	82	56.5	65.5	60	45	70	72	32	38	35	39	43	40
15	65	82	75	71	71	75	49	70	69	61	86	78	39	43.5	46	38	39	41.5
16	66	82	79	64	80	69.5	62	92.5	81.5	76	83	77	57	46	37	37	44	44
17	69	77.5	72	58.5	68.5	64	66	65	57	41	46	40	32	35.5	30	28	31.5	39.5
18	72	83	76	59	72	70	45	61	62.5	31.5	55	49	28.5	33	29	20	22.5	22
19	68.5	78	80	60	67	62	59	58	59	43	55	53	28	32	34	14	17.5	15
20	70	77	72	56	66	63	48	50	45	45	57	56	38	51	49.5	17	23.5	26
21	71.5	83	81.5	55	73	68	41.5	55	55	49	49	50	45	60	46.5	25	26	25
22	69	86	85	58.5	77	68	44	66	61	48.5	53	49	28	33.5	29	26	30.5	25
23	67	69	71.5	55	67	63.5	50	59.5	51	40	53	51.5	27	24	17	21	21.5	16.5
24	66	73	74	59	70	69	52	57	59.5	38	61	54.5	20	31	28.5	3	11	7.5
25	69	74.5	74	64.5	70.5	68	51	74	66	47.5	57	50.5	31.5	34	37	12	25.5	24.5
26	67.5	80	68	60	69	67.5	55.5	77.5	59	41.5	53	53	51	58	58	29	31	30
27	59	61	63	57	77	75	45	56.5	49.5	40	62	58	30	27	26	24	27	19
28	60	67	67	60	72	68	41	52	52	50	67	63	23	35.5	33	11	21.5	18
29	65	63.5	65	61	81	77.5	43	67	61	42	42	40	35	37	26	16	26.5	28
30	63	78	77	59	70	66	51	79	74	34	40	41	20	25	23	38	40.5	34
31	70	79	74	57	73	67	......	......	......	41	57	52	......	......	......	31	30	23
Average	68.9	79.7	76.4	61.6	74.7	71	54.9	70.6	66.2	46.2	59.3	55.6	36.6	41.9	38.4	27.5	33.1	30.8

SUMMARY OF MAXIMUM, MINIMUM AND STANDARD AIR THERMOMETERS.

	Maximum.	Minimum.	Standard. 7 a. m.	Standard. 12 m.	Standard. 6 p. m.
	Ave.	Ave.	Ave.	Ave.	Ave.
January	31.4	15	21.1	27.1	23.7
February	33.2	19	24	30	27.6
March	42.6	25	30.5	38	35.5
April	55.2	34.9	40.6	51.6	47.4
May	65.1	45.7	51.5	61.2	58.8
June	72.9	51.8	59.7	69.9	66.6
July	83.2	63.9	68.9	79.7	76.4
August	78.8	56.4	61.6	74.7	71
September	75.3	49.4	54.9	70.6	66.2
October	65.1	40	46.2	59.3	55 6
November	47.2	32.1	36.6	41.9	38.4
December	36	22.4	27.5	33.1	30.8

READINGS OF MAXIMUM AND MINIMUM THERMOMETERS AT 7 A. M.

	January.		February.		March.		April.		May.		June.		July.		August.		September.		October.		Novemb r.		December.	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
1	39	19	24	5.5	22.5	-1	46	28	69.5	47	64	45.5	74	58	79.5	60.5	77	56	86	50	58.5	41	27.5	20
2	41	28	33	16.5	39	10	47	29	67.5	55	57	42	84.5	59	75	57	76.5	57.5	81	49	52	46	36	10
3	45	37	33	21	40	23	57.5	29	65	44	67.5	48	81	61	82	61	73	47	67	37	49	41	31	10.5
4	56	36	27.5	18.5	51	23	46	28	60	45	80	49.5	88.5	67	87	64.5	70	44	66	36	54	39	32	26
5	58	30	33	14	36	21	55	36	55	42	72	48	91	72	87	62	78	49.5	74.5	37	64	39	42	30.5
6	38.5	16	36	18	51	30	67	44.5	65	42.5	73	48	95	72	83.5	55.5	90	55.5	79	45	65	46	35.5	22
7	28	16	43	33	31	10	49.5	35	59	42	76.5	53	87	64.5	81	55	91	59	62	47.5	49	39	34	22
8	31.5	18.5	40	33	31	11.5	42.5	32	54	32.5	69	51	90	66	84	58	82	61	54	32	51	33	39.5	32
9	33.5	16	35.5	26.5	42	28	48	33	62.5	41.5	57	51	93	69	80	61	88	59	60	35	46	37	43.5	33
10	39.5	11	33	18	43	35	40	29	79	52	61	52	96	69.5	83	65	95	62.5	50	30	56.5	33.5	57.5	38
11	37	25	26	11	47	30	38	27	65	46	66.5	54	97	69.5	78	58	98	62.5	58	32	48	33.5	58	45.5
12	33	11	24	10	47.5	31	42	29	73	53	79	54	95	64	75.5	58	82.5	47	70	54	48	34	61.5	35.5
13	13	8	23	14	55	28	55	35	70	53	72	52	66	62	78	51	77	50	73	43	39	32	38.5	34
14	28	5	27	13	32	15	59	40	62	48	75	55	77	61	79	55	80	52	64	42.5	35.5	31.5	43.5	34
15	25	4	45	22	40	17	49	38	70	45	76	54.5	79	57	87.5	61	67.5	44	79	44	41	32	43.5	36
16	28	17	33.5	27.5	31	14	44.5	37	61	40	79	55	82.5	58.5	79	62.5	76	47.5	88	60	57	39	42	36
17	38	25	37	24	13	24	58	38	62	39.5	74	48.5	85.5	65	80	56.5	95.5	61	86	40	59	31.5	46	26.5
18	43.5	27	49.5	31	41	17	46	32	70	48	73.5	51	83	64	72	54	67	42	49	30	36	27	42	19.5
19	34	3	37.5	26	48	37	64	36	74.5	43	76	50	84	65	76.5	55	70.5	44	61	31.5	36	26	23.5	14
20	9	—3.5	32.5	19	56	40	55	19	65	47	81	58	82.5	67	77	51.5	64	47	59	41	38	28	18	6
21	37	8	38	12.5	64	40	36.5	20	78	50	66	45	83	63.5	68	46	51	37.5	57	44	54	38	29.5	15
22	38.5	22.5	43.5	26	49.5	31	58	31	60	40.5	67	45	86	68	79.5	54.5	61	41	51	47	62.5	28	28	20.5
23	38.5	22	39	25	61.5	31	77	45	64.5	45.5	79	53	90.5	66	81	52.5	70.5	43	54	37	34.5	24.5	31	17
24	27.5	11	37.5	20	51.5	35	79	54	80	51	87.5	64.5	79.5	64	70	54	61	49	63	36	28	16.5	24	2
25	17	2	31	19	44.5	29	74	54	70	45	87.5	64	79.5	65.5	76	58	63	49	65	37.5	35.5	20	13	3
26	13	3	37	12	33	27	82	40	50	40	78.5	52	81	64.5	75	52.5	78	50	60	40	51	33	29	12
27	17	11	17	5.5	35	26	60	32	59	42	66	49	80	58.5	75	51	79	44	63.5	36	60	30	35	24
28	20	11	20.5	9	38	26	47	32	63	49.5	72	45	64	58	82.5	55.5	64	38.5	69	39	30.5	20	28	11
29	16.5	10	......	......	40	25.5	60.5	37.5	61	44	81	55	70	59.5	74.5	54	59	40	72	41.5	38.5	23	24.5	11
30	24	10	......	......	50	30	72	45.5	61	49	72.5	60	70	61	83	57	72.5	42	48	32.5	38	20	38	16
31	25	5	......	......	57	31	.....	.....	62	53	.....	.....	83	62.5	74	51	......	......	49	33	......	......	41	30.5
Average	31.4	15	33.2	19	42.6	25	55.2	34.9	65.1	45.7	72.9	51.8	83.2	63.9	78.8	56.4	75.3	49.4	65.1	40	47.2	32.1	36	22.4

READINGS OF SOIL THERMOMETERS.

	One Inch.			Two Inches.			Three Inches.			Six Inches.			Nine Inches.			Eighteen Inches.		
	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.
May 1	54	57	57	54.5	57.5	57.5	53	55	56	53	53.5	51.5	52.5	51.5	52	49	49	49
2	54.5	57	56.5	54.5	57.5	56.5	53.5	55.5	55	53.5	53.5	54	52	52	52	49.5	49.5	49.5
3	50.5	56	57	50.5	56.5	58	50.5	54	57	52	52	55	51.5	51	52.5	49.5	49.5	49.5
4	50.5	53.5	53.5	51	53	54	50.5	51.5	53	51.5	51.5	52.5	51	51	51	50	50	50
5	49.5	59.5	62	49.5	60.5	63	48	57	60.5	50.5	52.5	57	50	50.5	53	49.5	49.5	49.5
6	51	59.5	60.5	51	60	61.5	51	57.5	60	53	54	57.5	52.5	52.5	54	50.5	50.5	50.5
7	50.5	58.5	58	50.5	59	59	50.5	57	58	52.5	54	56.5	52.5	52.5	54	51	51	51
8	46	59	59.5	46	59	60	46.5	55.5	58	50	52	56	51	51	53	51	51	50.5
9	49.5	62	61.5	49.5	62	61.5	49	57.5	59.5	51	53.5	56.5	51.5	51.5	54	51	52	51
10	58	57.5	59	58	58	60	56.5	56.5	58.5	55.5	56	56.5	54	54	54.5	51.5	52	52
11	52	61.5	61.5	51.5	62	61.5	51.5	59	60	53	55	58	53	53	55	52	52	52
12	57.5	60.5	62	57.5	61	63	56.5	58.5	61	56	56.5	59	55	55	56	52.5	52.5	53
13	56	58	58.5	56	58	59	55.5	57	58	56	56.5	57.5	55	55	55	53	53	53
14	54	59.5	59.5	54	59.5	60	53.5	58	59.5	54	56.5	58	54	54	55	53	53	53
15	51	60	59	51	61	60	51	58.5	58.5	53	55.5	57.5	53.5	53.5	55	53	53	53
16	50.5	63.5	61.5	50.5	65.5	62	50	61	61.5	52	56	60	53	53	56	53	53	53
17	51	63.5	62.5	50.5	64	63	50.5	60	61.5	53	56	59.5	54	54	56	53	53	53
18	54.5	64	63	54.5	65.5	64	54	61.5	62.5	55	57.5	60.5	55	55	57	53.5	54	54
19	52.5	65	62.5	52	66	62.5	52.5	61.5	61	54.5	57.5	59.5	55	55	56.5	54	54	54
20	57	65	62	57	65.5	62.5	55.5	62	61	56	58.5	60	55.5	56	57	54	54.5	54.5
21	56	54	57	56	54.5	57.5	56	55	56.5	57.5	56.5	56.5	56.5	56	55.5	54.5	54.5	54.5
22	48.5	65	62.5	48.5	65.5	63	49	60.5	61.5	52	55.5	59.5	53	53	56	54	54	54
23	54.5	62.5	61.5	54.5	62	61.5	53.5	59.5	60.5	54.5	56.5	59.5	54.5	54.5	56.5	54	54	54
24	55.5	64	59.5	55.5	64.5	59.5	55	61.5	58.5	56	58	59	55.5	55.5	57	54.5	54.5	54.5
25	53	53.5	55	53.5	53.5	55	53.5	53	54	55.5	54.5	54.5	55	54.5	53	54.5	54.5	54
26	49	65	62	49	66	62	49	60.5	61	51.5	55.5	59.5	52.5	53	56	53.5	53.5	53.5
27	51.5	66	63	51.5	66.5	62.5	51.5	61.5	62	53.5	56.5	60.5	54	54.5	57	54	54	54
28	53.5	57.5	57	53.5	57.5	57	55	56	56.5	55.5	56	56.5	55.5	55	55.5	54.5	54.5	54.5
29	51.5	57.5	59.5	51.5	57.5	60	52	55	59	53	54.5	58	54.5	54	56	54.5	54.5	55
30	51.5	61.5	60	51.5	61	60	51.5	58	59	53.5	55.5	57	54	54	56	54	54	55
31	55	64	61	55	64.5	61	54	60.5	60.5	55	57.5	60	55	55.5	57	54.5	54.5	54.5
Average	52.6	60.3	59.8	52.6	60.8	60.2	52.2	57.9	59	53.6	55.3	57.6	53.6	53.6	55	52.6	52.7	52.7

READINGS OF SOIL THERMOMETERS — *Continued.*

	ONE INCH.			TWO INCHES.			THREE INCHES.			SIX INCHES.			NINE INCHES.			EIGHTEEN INCHES.		
	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.
June 1	53.5	55	57	53.5	54.5	57	53.5	53.5	55	55.5	55	55	55.5	55	55	55	55	55
2	50.5	64.5	63	50.5	64.5	62.5	50.5	60	61	53	56	59.5	51	54	56.5	54.5	54	54
3	58.5	66	67	58.5	65.5	67	57	63	65	55.5	60	62.5	56	57	59	56	55	55.5
4	62.5	68	66.5	62.5	68	66.5	61	65.5	65.5	60.5	62.5	64.5	59	59.5	60.5	56	56.5	57
5	59	69.5	67	59	70	66.5	58.5	65.5	65.5	59.5	62	64.5	59.5	59.5	61.5	58.5	58	57.5
6	58	70	66	58	69.5	65.5	57.5	65	65.5	59	62	64	59	59.5	61.5	58	58	58
7	60	64.5	62.5	60	64.5	62.5	59	62.5	61.5	60	61.5	61.5	59.5	59.5	60	58	58	58
8	56	58.5	58	56.5	58.5	58.5	56	57.5	57.5	57	58	58	58.5	57.5	57.5	58	57.5	57
9	57	60	59.5	57	60	59.5	56.5	58.5	58.5	57.5	58	58.5	57	57	57.5	56.5	56.5	56.5
10	57	62.5	64.5	57	62.5	64.5	56.5	60	63	57.5	58.5	61	57	57	58.5	56.5	56.5	56.5
11	58.5	73.5	57.5	58.5	75	62	57	69.5	66.5	58	62.5	69	58	58.5	60.5	57	57	57.5
12	61.5	69	69.5	61.5	69.5	69.5	61.5	67	68.5	62.5	61	66.5	61.5	61	63	58.5	59	59
13	61.5	72	70.5	61.5	73	71	60.5	69.5	70	61	64	67.5	61	61	63.5	59.5	59.5	59.5
14	61.5	75.5	71.5	61.5	76.5	71	60.5	72	70	62	65.5	68.5	62	62	65	60	60	60
15	62.5	77	69	62.5	77	69	61	72.5	68.5	62.5	66.5	67.5	62.5	63	64.5	61	61	61
16	62	76.5	72	61.5	76.5	71.5	60.5	71.5	70.5	62.5	66	69	62.5	62.5	65	61	61	61
17	60	72	67	60	73	67	60	68.5	66.5	62	63.5	66	62.5	62	63.5	61	61	61
18	61	76.5	73	60.5	77	72.5	60	72	71.5	61.5	55.5	69.5	61.5	62	65	61	61	61
19	61	74.5	72	61	74.5	72	60.5	70	70	61.5	65.5	68	63	63	65	61.5	61.5	61.5
20	64.5	73.5	68	64.5	73.5	67.5	64	69.5	67.5	64.5	66	67.5	64	64	65	61.5	62	61.5
21	57.5	69	66.5	57	68.5	66.5	57	65	66	60	62.5	65.5	61	61	63	61.5	61	61
22	58	73	70.5	57.5	72	70	57	67.5	69	59.5	63	67	60.5	60.5	63	61	60.5	60.5
23	61.5	75	73.5	61.5	73.5	73	60.5	69.5	71	61	65	68.5	62	62	64.5	61	61	61
24	67	79	73.5	67	78	73.5	65.5	73.5	72	65.5	73.5	70.5	64	64.5	67	62	62	62
25	67	77.5	74	67	76.5	74	66	72.5	73	66.5	69.5	72	65.5	66	68	63	63	63
26	62.5	73.5	69.5	62.5	73	69.5	62	69	68	64	67	69.5	65	64.5	66.5	63.5	63.5	63
27	60	72	70	60	71	69.5	59.5	67.5	69	62	65	68.5	63	63	65.5	63	63	62.5
28	59	74	71.5	59	72.5	71.5	59	68	70.5	61.5	65	69	63	62.5	65.5	62.5	62.5	62.5
29	63	68.5	65.5	62.5	67.5	65.5	62	66	65	63.5	65.5	65.5	64	64	64	63	63	62.5
30	66.5	67.5	71	66.5	67	71	65.5	66	70	65.5	65.5	68	64	64	65	62.5	62.5	62.5
Average	60.3	70.2	67.5	60.2	70.1	67.6	59.5	66.6	66.7	60.7	63.5	65.7	60.9	60.9	62.6	59.7	59.7	59.6

READINGS OF SOIL THERMOMETERS (*Continued*).

	One Inch.			Two Inches.			Three Inches.			Six Inches.			Nine Inches.			Eighteen Inches.		
	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.
July 1	65	76.5	75	64.5	76	75	63.5	71.5	73.5	64.5	68	71.5	64.5	65	68	63	63	63
2	66.5	72	74	66.5	71.5	74	65.5	69.5	72.5	66.5	68	70.5	66	66	67.5	64	64	64
3	67.5	79.5	77	67	79	77	66	74.5	76	67	70.5	74	66.5	67	69.5	64.5	64.5	65
4	70	79.5	79	70	79	79	69	75.5	77	69.5	72	75	68.5	69	71	65 5	66	66
5	73	81.5	80	72.5	81	80	71.5	77	78.5	71.5	74	76.5	70	70.5	72.5	67	67	67
6	73	79	79.5	73	78	79.5	72	75	78.5	72	73.5	76.5	71	71	72.5	67.5	68	68
7	71.5	83	80.5	71	81	80	70	77.5	79	71	74	77	70.5	71	73	68	68	68
8	72	84	81.5	72	82	81	71	78.5	80	72	74.5	77.5	71.5	71.5	73.5	69	69	69
9	74	85	82	73.5	83	81.5	72.5	79.5	80	73	75.5	78.5	72	72.5	74.5	69.5	69.5	69.5
10	75	87	83.5	74.5	84	83	73.5	80	81.5	73.5	76.5	79.5	72.5	73	75	70	70	70
11	74	81	73·5	73.5	79.5	73.5	73	77	73	73.5	74.5	.74	73	72.5	73.5	70.5	70.5	70.5
12	71	71	71	71	71	71	70.5	70.5	70.5	71.5	71	71	71	70.5	70	70	69.5	69
13	68.5	74	75.5	68.5	73.5	75	68	72	74.5	69	70 5	73	69	69	70.5	68.5	68.5	68
14	69	74.5	74.5	69	74	74	68.5	72	73	69.5	71	72	69	69.5	70.5	68	68.5	68 5
15	66.5	76	75	66.5	75	74.5	66.5	72.5	73	68.5	70.5	72.5	69	69	70	68	68	68
16	67	77.5	76	67	76.5	75.5	66.5	73	74	68.5	71	73	69	69	70	68	68	68
17	70	73.5	74.5	70	73	74	69.5	71.5	73.5	70	71	73	69.5	69.5	70.5	68	68	68
18	70	80.5	76.5	69.5	79.5	76.5	68.5	75.5	75.5	69.5	71	74.5	69	69.5	71.5	68	68.5	68.5
19	69	79	78	69	78.5	78.5	69	75.5	77	70	72	75	70	70	71.5	68.5	68.5	68.5
20	70.5	76.5	74.5	70.5	76	74.5	70	74	73.5	70.5	72	73	70	70	71	69	69	69
21	69	80	78.5	69	80	79	68	76.5	77.5	69	72	75	69	69.5	71.5	68.5	68.5	68.5
22	71	84	80	71	82.5	80.5	70.5	78.5	79.5	71	74	77	70.5	71	73.5	69	69	69
23	69.5	71.5	72	70	71.5	72	70	71	72	71.5	72	72	71	71	70.5	69.5	69	69
24	67.5	72.5	75.5	67.5	72,5	75.5	67	70.5	75	68.5	69.5	73.5	69	69	70.5	68.5	68.5	69
25	69·5	74.5	77	69.5	74.5	77	69	72	75.5	70	71	74	69.5	69.7	71	68.5	68.5	68.5
26	70	80.5	72	70	79.5	72	69	75.5	72	70.5	73	72.5	70	70.5	71.5	69	69	69
27	65	65	65	65	65	65.5	65.5	65	65	68.5	67	66.5	68.5	67.5	67	68.5	68	67.5
28	62	66	67.5	62	66	67.5	62	65	66.5	64	65	66.5	65	65	65.5	66.5	66.5	66
29	64.5	66.5	68	64.5	67	68	64	66	67	65	66	67	65	66.5	66	66	66.5	65.5
30	65	75.5	75	65	75	75	65	72	73.5	65.5	69	72	65.5	66	69	65.5	66	66
31	67	75	72.5	67	74.5	72.5	66.5	72	72	68	70.5	72	67.5	68	70	67	67	67
Average	69.1	76.8	75.6	69	76.1	75.5	68.4	73.4	74.5	69.4	71.3	73.4	69.1	69.3	70.7	67.8	67.8	67.7

Readings of Soil Thermometers — (*Continued*).

	One Inch.			Two Inches.			Three Inches.			Six Inches.			Nine Inches.			Eighteen Inches.		
	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.
August 1	66.5	73.5	74	66.5	73	74	66.5	71	73	67.5	69.5	72	68	68	69.5	67	67	67
2	65	78.5	78	65	77	78	65	74	76.5	67	70	74.5	68	68	70.5	67.5	67.5	67.5
3	67	80.5	80	67	80	80.5	67	76.5	78.5	68.5	72	75.5	69	69	71.5	68	68	68
4	69	83	79	69	82.5	79	68.5	79	78.5	70	74	77	70	70.5	73	68.5	69	69
5	68.5	79	77	68.5	78.5	78	69	76	77	71	73	77.5	71	71	72.5	69.5	69.5	69.5
6	64.5	79.5	78.5	64.5	78	79	65	75.5	78	68	72	76	69	69.5	72	69.5	69.5	69.5
7	65	78	77.5	65	80.5	77.5	65	77	76	68	71.5	74.5	69	69	71.5	69	69	69
8	68	78	76	67.5	75.5	76	67	73	75	68	70.5	73	69	69	70	69	69	69
9	66.5	80	77.5	66.5	77	77.5	66	74.5	76.5	68	71	74	68	68.5	71	68.5	68	68
10	69	70.5	73.5	69	70	73.5	68.5	69	72.5	69.5	69	71.5	69.5	69	69.5	68.5	68.5	68.5
11	66.5	74	72.5	66.5	73	72.5	66	71	72	67.5	69.5	71	68	68	69	68	68	68
12	63	74	68.5	63	72.5	69	63.5	71	69	66	69	70	67	67	68.5	67.5	67.5	67.5
13	60	71	71.5	60	69	72	60.5	68	71.5	64	67	70.5	65.5	65.5	68	67	67	67
14	62.5	79.5	75.5	62.5	78.5	75.5	62.5	75.5	74.5	65	70	72	66	67.5	69	67	67	67
15	68	70	71	68	70	71	67	69	70.5	68	69	70	67.5	68	68	67	67	67
16	65	72.5	70	65.5	72	70	65.5	70.5	70.5	67	69	71	67	67	69	67	67	67
17	62	70	69	62	68.5	69	62.5	67.5	69	65	67	69	66	66	67.5	67	67	66.5
18	61	66.5	68	61	66.5	68.5	61	65.5	68	63.5	65.5	67.5	65	65	66	66	66	65.5
19	61.5	68.5	66	61.5	67.5	66	61.5	60	65.5	63.5	65.5	66	64.5	64.5	65	65.5	65.5	65
20	59	68	67.5	60	67	67.5	60	66	67.5	63	65	67	64	64	65.5	65	65	65
21	57.5	71	71	57.5	68.5	71	58	66.5	70	61	64	68.5	63	63	65.5	65	64.5	64.5
22	61.5	73.5	73	61.5	72	73	61.5	69	72	63.5	66	69	64	64.5	67	64.5	65	65
23	61.5	70.5	68.5	61.5	69	68.5	62	67.5	68	64	65.5	68	65	65	66	65	65	65
24	62.5	70.5	71.5	62.5	70	71.5	62.5	67.5	70.5	64	65.5	69.5	64.5	64.5	67	65	65	65
25	64.5	68.5	70	64.5	68.5	70	64.5	67	69.5	65.5	66.5	69.5	65.5	65.5	67	65	65.5	65.5
26	61	70	71	61	70	71	61	68	70.5	63.5	66	69.5	64.5	64.5	67	65.5	65.5	65.5
27	60	69	70	60	68.5	70	60.5	66.5	68.5	63	65	68	64	64	66	65	65	65
28	62.5	71.5	70.5	62.5	71.5	70.5	62	69	70	64	66.5	69.5	65	65	67	65	65	65
29	62	72	70.5	62	71.5	70.5	61.5	69	69.5	63.5	66.5	68	64	66	66	65	65	65
30	64	71.5	71	64	71.5	71	64	69	70.5	65.5	67	70	65.5	65.5	67	65	65	65
31	60	70.5	70	60	69.5	70	60.5	68	69	63.5	66	68.5	64.5	64.5	66	65	65	65
Average	63.7	73.3	72.5	63.7	72.5	72.6	63.7	70.3	71.9	65.8	68.2	70.9	66.5	66.6	68.3	66.7	66.7	66.6

READINGS OF SOIL THERMOMETERS — (*Continued*).

	One Inch			Two Inches.			Three Inches.			Six Inches.			Nine Inches.			Eighteen Inches.		
	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.
September 1	62	70	68	62	69.5	68	62	68	67.5	64	66	67.5	64.5	64.5	66	65	65	65
2	63	72	71	63	72	71	63	69.5	71	64.5	67	69	65	65	67	65	65	65
3	59	70.5	70	59	70.5	70	60	68	69.5	63	65.5	69	64	64	66	65	65	65
4	57	70.5	70	57	70	70	58	67	69	61	64	68	63	63	65	64.5	64.5	64
5	59.5	73	74.5	59.5	73	74.5	59.5	69.5	72.5	62	65.5	70	63	63.5	66	64	64.5	64
6	62.5	74.5	77	62.5	74.5	77	62.5	71	75	64.5	67	72	65	65	68	64.5	65	65
7	66	74.5	75.5	66	73.5	75.5	65.5	71	74	67	69	72	66.5	67	68.5	65.5	65.5	65.5
8	66.5	78	.77	66.5	77	77	66	74	75.5	67.5	70	73	67	67.5	69.5	66	66	66
9	65	79.5	80	65	79.5	79.5	65	75.5	77.5	67	70	74.5	67	67.5	70	66.5	67	66.5
10	69	81	81.5	69	81	81.5	68.5	77	79	69	72	76.5	69	69	72	67	67.6	67.5
11	69	74	71.5	69	74	71.5	69	72.5	71	70.5	71.5	71 5	70	69.5	70	68	68	68
12	60	72	70.5	60.5	70.5	70.5	61.5	68.5	69.5	64.5	67	69	86	66	67	67	67	66.5
13	66	69	72	66	69	72	65.5	68	70.5	66.5	67.5	69.5	66	66	67	66	66	66
14	61.5	68	68	62	68	68	62	67	68	65	66	68	65.5	65	66	66	66	65 5
15	57	66.5	69.5	57	66.5	69.5	58	64	63	61	62.5	67	63	62.5	64.5	65	65	64.5
16	60.5	73	74.5	60.5	72	74.5	60.5	68.5	72.5	62.5	65	70	63	63.5	66.5	64	64.5	64
17	67.5	68.5	66.5	67.5	68.5	66.5	67	67.5	66.5	67.5	67.5	68	66.5	66.5	67	65	65.5	65
18	56	61	64	56	61	64	57.5	60	64	61	61.5	64.5	63	62	63	64.5	64	64
19	56.5	59	61.5	56.5	59	61.5	57	58.5	61	60	60	61.5	61	60.5	61	93	63	62.5
20	55	56	55.5	56	56	55.5	56	56	56	59	68.5	59	60	59.5	59.5	62	62	61.5
21	50	58.5	60	50.5	58.5	60	51	56.5	60	55	56	60	57	57	59	61	60.5	60
22	50.5	62	62	51	61	62	51.5	58.5	61.5	55	57	61.5	57	57	59	60	60	59.5
23	54.5	60	57	55	59.5	57	55	58.5	57.5	57	58.5	59	58	58	59	59.5	60	59.5
24	55	57.5	59.5	55	57.5	59.5	55	57	58.5	57	57	59	57.5	57.5	58	59.5	59.5	59.5
25	54.5	65	65	54.5	65	65	54.5	62.5	64	56.5	59.5	63.5	57	59.5	61	59	59	59
26	56.5	65	62	56.5	65	62	56.5	64.5	61.5	58.5	60.5	62	59	59	60.5	60	60	60
27	53.5	60	57.5	53.5	60	57.5	54	58	57.5	57	56.5	59.5	58.5	56	59	60	59	59.5
28	50	59	58.5	51	59	58	51	58	58	54.5	58	59	56	58	58	59	59	58.5
29	51	59.5	60.5	51	59.5	61	51.5	57	59.5	54	56	59	55.5	55.5	57	58	58	58
30	53.5	64	66.5	54	64	66.5	54	61	65	56	58	63	56.5	57	60	58	58	58
Average	58.9	67.4	67.6	59.1	67.1	67.5	59.3	65.1	66.7	61.6	63.3	66.2	62.3	62.4	64	63.3	63.3	63.1

READINGS OF SOIL THERMOMETERS — (*Concluded*).

	One Inch.			Two Inches.			Three Inches.			Six Inches.			Nine Inches			Eighteen Inches.		
	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.	7 a. m.	12 m.	6 p. m.
October 1	58	68	64.5	58	68	64.5	58	65	64	59.5	61.5	63.5	59	59.5	61	59	59.5	59
2	57	59.5	60.5	57	59	60.5	57.5	59.5	60.5	59	59	61	59.5	59.5	59.5	59.5	59.5	59.5
3	51	58	58	51.5	58	58	52	57	58.5	55.5	56.5	59	57	56.5	58	59	59	58.5
4	49	60.5	61	51	60.5	61	51	58	60	54	56	60	55.5	55	57.5	58	58	57.5
5	51.5	71.5	62.5	52	61.5	62.5	52.5	59.5	61.5	55	57	60.5	56	56	58	57.5	57.5	57.5
6	57.5	59.5	58	57.5	59.5	58	57	58.5	57.5	58	58.5	58.5	57.5	57.5	58	58	58	58
7	54.5	53	51.5	55	53.5	52	54.5	54	52.5	56.5	56	55	56.5	56	55.5	58	57.5	57.5
8	45.5	54.5	54	48.5	54.5	54	47.5	53	54	51	52.5	54.5	53	53	54	56.5	56.5	56
9	51.5	57	53.5	52	57	54.5	52	56	55	53.5	55	56.5	54	54	55.5	56	56	56
10	44.5	56	53.5	45.5	55.5	54	46.5	54	53.5	50	52.5	54.5	52	52	53.5	55.5	55.5	55
11	53.5	59.5	60	54	59	60	53	57	58.5	53	55	57.5	53	54	55.5	55	55	55
12	62.5	50.5	60.5	62.5	60.5	61	60.5	60	60.5	59.5	59.5	61	57	58	58.5	56	56.5	55.5
13	51.5	62	59.5	62	63	60	53	60.5	60	55.5	58	60	56	56	58	57	57	57
14	50.5	60.5	63	51.5	61	63	51.5	58.5	61.5	51.5	56.5	60	55.5	55	57.5	57	57	57
15	59.5	70.5	70	59.5	71	70	58.5	67.5	68.5	59	62	66	58	59	62	57	58	58
16	66	70.5	70	66	70	70	64	67.5	68.5	63.5	65	66.5	61.5	62	63	59	59.5	60
17	54	58	55.5	54	58	56.5	55.5	58	57	59	58.5	59.5	60	59	59	60	60	59
18	47	54.5	56	49	54.5	56.5	49	54.5	56.5	53	54	57	55	54.5	56	58	58	57
19	49.5	53.5	54.5	50	53.5	54.5	50	52.5	54	53	53.5	57	54.5	54	54.5	57	56.5	56
20	50.5	54	54.5	51	54	54.5	51	53	54	53	53.5	54.5	53.5	53.5	54	56	56	55.5
21	52	51	51	52.5	51	51.5	52	51	51.5	53.5	53	52.5	54	53.5	53	55.5	55.5	55
22	50.5	52.5	52	51.5	52.5	52.5	51	52	52	52.5	52.5	53	53	53	53	55	55	54.5
23	47	52.5	55	48	52.5	55.5	48	52	55	50.5	52.5	55	52	53	54.5	54.5	55	54
24	47	57.5	56.5	47.5	58	57	48	55.5	56	51	53	56	52	52	54	54	54.5	54
25	51	55.5	54	51.5	55.5	55	51.5	54	54.5	53	53.5	55	53.5	53.5	54.5	54.5	54.5	54
26	49.5	53	55.5	50	53	56	50	52	55.5	52	52.5	55	53	52.5	54	54.5	54.5	54
27	48.5	57	56.5	49	57	57	49	54.5	56	51	52.5	55.5	52.5	52.5	54	54	54	54
28	50.5	57	57	51	57	57.5	50.5	54.5	56.5	52.5	53	55.5	53	53	54	54	54	54
29	49.5	50.5	48	50	51	49	50.5	51	49	53	52.5	51.5	53.5	53	52	54.5	54	54
30	43	46	47	47.5	47.5	49.5	44.5	46.5	47.5	47.5	48	49.5	50	49	50	53	53	52.5
31	44.5	50.5	51	49.5	50.5	52	45	48.5	50.5	47.5	48.5	50.5	49	49	50	52	52	52
Average	51.5	57.2	56.9	52.4	57.3	57.3	52.1	56	56.8	54.2	55.2	57.1	54.8	54.8	55.9	56.3	56.3	56

SUMMARY OF SOIL THERMOMETERS.

	One Inch.				Two Inches.				Three Inches.				Six Inches.				Nine Inches.				Eighteen Inches.			
	7 a. m.	12 m.	6 p. m.	Average.	7 a. m.	12 m.	6 p. m.	Average.	7 a. m.	12 m.	6 p. m.	Average.	7 a. m.	12 m.	6 p. m.	Average.	7 a. m.	12 m.	6 p. m.	Average	7 a. m.	12 m.	6 p. m.	Average.
	Ave.	Ave.	Ave.		Ave.	Ave.	Ave.		Ave	Ave.	Ave		Ave.	Ave.	Ave		Ave.	Ave.	Ave.		Ave.	Ave.	Ave	
May	52.6	60.3	59.8	57.6	52.6	60.8	60.2	57.9	52.2	57.9	59	56.4	53.6	55.3	57.6	55.5	53.6	53.6	55	54.1	52.6	52.7	52.7	52.7
June	60.3	70.2	67.5	66	60.2	70.1	67.6	66	59.5	66.6	66.7	64.3	60.7	63.5	65.7	63.3	60.9	60.9	62.6	61.5	59.7	59.7	59.6	59.7
July	69.1	76.8	75.6	73.8	69.6	76.1	75.5	73.5	68.4	73.4	74.5	72.1	69.4	71.3	73.4	71.4	69.1	69.3	70.7	69.7	67.8	67.8	67.7	67.8
August	63.7	73.3	72.5	69.8	63.7	72.5	72.6	69.6	63.7	70.3	71.9	68.6	65.8	68.2	70.9	68.3	66.5	66.6	68.3	67.1	66.7	66.7	66.6	66.7
September	58.9	67.4	67.6	64.6	59.1	67.1	67.5	64.6	59.3	65.1	66.7	63.7	61.6	63.3	66.2	63.7	62.3	62.4	64	62.9	63.3	63.3	63.1	63.2
October	51.5	57.2	56.9	55.2	52.4	57.3	57.3	55.7	52.1	56	56.8	55	54.2	55.2	57.1	55.5	54.8	54.8	55.9	55.2	56.3	56.3	56	56.2

INDEX.

A.

H.

I.

J.

PAGE.

K.

L.

M.

P.

PAGE.

S.

INDEX

TO

ASSEMBLY DOCUMENTS

1898.

A.

B.

C.

G.

H.

I.

L.

N.

P.

Reports:

Reports: